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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Introduction

WHAT *STAR* IS

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Scientific and technical reports of the National Aeronautics and Space Administration and its contractors; scientific and technical reports of government agencies, universities, and research organizations throughout the world.

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The Preliminary Edition of the *NASA Thesaurus* (December 1967) (NASA SP-7030) is used as the authority for the indexing vocabulary that appears in the subject index to this issue. The terminology has been modified from the *Guide to the Subject Indexes for STAR* (NASA SP-7016), the authority used for the vocabulary to indexes published prior to 1968. The *NASA Thesaurus* should be consulted in examining the current indexing vocabulary, including associated cross reference structure. Only the subject terms that have been selected to describe the documents abstracted in this issue appear in the subject index. Copies of the *NASA Thesaurus* may be obtained from the Clearinghouse for Federal Scientific and Technical Information or the U. S. Government Printing Office at $8.50 for the three-volume set.

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02 AIRCRAFT
Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **3619**

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Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **3667**

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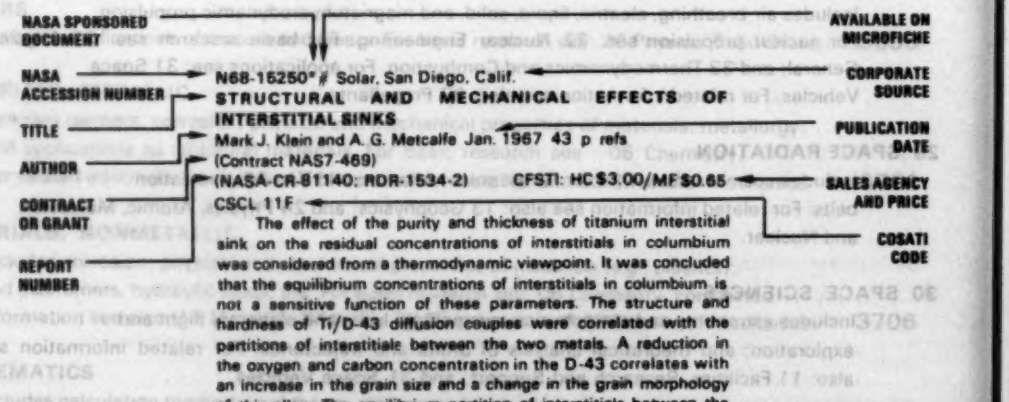
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N68-16250* # Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2)
CFSTI: HC $3.00/MF $0.65
CSCL 11F
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43.
Author

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Scientific and Technical Aerospace Reports

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01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N68-33765*# Nielsen Engineering and Research, Inc., Palo Alto, Calif.

INVESTIGATION OF METHODS FOR PREDICTING THE AERODYNAMIC CHARACTERISTICS OF TWO-LOBED PARAWINGS

M. R. Mendenhall, S. B. Spangler, and J. N. Nielsen Washington NASA Sep. 1968 125 p refs

(Contract NAS1-6615)

(NASA-CR-1166) CFSTI: HC$3.00/MF$0.65 CSCL 01A

The present study seeks to develop accurate methods for predicting the longitudinal aerodynamic characteristics of two-lobed conical parawings with leading-edge booms for high aspect ratios and high slackness. For prediction purposes, the assumption was made that the booms and canopy can be considered separately. The canopy was then considered to have a known shape for purposes of determining its aerodynamic performance. Various theoretical methods were studied for determining canopy aerodynamic characteristics, including profile drag. Force increments due to the leading-edge booms were studied both analytically and empirically. Comparisons were made between theory and data for rigid wings of known shape with no leading-edge booms to check the canopy prediction methods. Comparisons were also made for flexible wings of triangular and NASA planforms with leading-edge booms for overall evaluation of the methods. The canopy shape assumption was checked by comparison with earlier slender-body results, and the aerodynamic performance was found to be insensitive to small shape differences. Author

N68-33774 Rice Univ., Houston, Tex.

TWO-DIMENSIONAL, HYPERSONIC WINGS OF MAXIMUM LIFT-TO-DRAG RATIO

David George Hull (Ph.D. Thesis) 1967 55 p

Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-13085

The problem of maximizing the lift-to-drag ratio of a slender, two-dimensional, flat-top wing at hypersonic speeds is considered under the hypotheses that the pressure coefficient is modified Newtonian, the average skin-friction coefficient is constant, and the base drag is negligible. After an upper bound is imposed on the chord and after arbitrary conditions are imposed on the thickness and the profile area, the indirect methods of the calculus of variations are used to obtain the necessary conditions which must be satisfied by an optimum airfoil. Then, the absolute maximum lift-to-drag ratio is determined, and the particular cases of given thickness and given profile area are analyzed in detail. Finally, the effects of base drag, leading edge blunting, and inclining the upper surface on the absolute maximum lift-to-drag ratio are investigated. Dissert Abstr.

N68-33778# National Aeronautical Establishment, Ottawa (Ontario).

PERTURBATIONS OF SIMPLE WEDGE FLOW RELATING TO AXISYMMETRIC HYPERSONIC INTAKES OR IMPLODING CYLINDRICAL SHOCKS

R. F. Meyer Jan. 1968 30 p refs

(NRC-LR-496; NRC-10172) CFSTI: HC$3.00/MF$0.65

The flow near the leading edge of a sharp-lipped, finite angle axisymmetric intake is studied within the approximations of the hypersonic small disturbance theory. The radial distance of the unperturbed shock measure inwards from the intake lip is non-dimensionalised with respect to the lip radius and this quality taken as a small parameter τ. Solutions are obtained as series expansions to the second order in τ and the results may be applied to any shock shape, or surface shape, expressed as a series in τ without further computation. Comparisons are made with exact numerical calculations for the cases of the internal conical surface and of the internal conical shock to indicate range of application of the solutions. The results may be applied to the equivalent unsteady flow problem. Dissert. Abstr.

N68-33836*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS OF SEVERAL HYPERSONIC BOOST-GLIDE-TYPE CONFIGURATIONS AT MACH NUMBERS FROM 2.30 TO 4.63

Ernald B. Graves and Melvin M. Carmel Washington Sep. 1968 27 p refs

(NASA-TM-X-1601) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Two all-wing and three wing-body configurations were tested through an angle-of-attack range from about $-4°$ to $33°$ and an angle-of-sideslip range from $-4°$ to $8°$ at a Reynolds number of 3×10^6 per foot (9.84×10^6 per meter). The results of the investigation indicate that the wing-body configurations produced higher values of maximum lift-drag ratio than those produced by the all-wing models. The high wing-body configurations tend to have a self-trimming capability as opposed to that for the low wing-body configurations. Each of the configurations produced a positive dihedral effect that increased with increasing angle of attack and decreased with increasing Mach number. The high wing-body models produced decreasing values of directional stability with

increase in angle of attack, whereas the low wing-body provided increasing values of directional stability with increase in angle of attack. Author

N68-33962# Southampton Univ. (England). Inst. of Sound and Vibration Research.
THE FLAPPING TORSION FLUTTER OF A HELICOPTER BLADE IN FORWARD FLIGHT
C. W. Stammers Feb. 1968 45 p refs
(ISVR-TR-3) CFSTI: HC$3.00/MF$0.65

The essential complication in the analysis is the presence of periodic coefficients in the equations of motion; approximate solutions are obtained by use of a perturbation procedure. An unusual behavior of the flutter equations which occurs when the fundamental frequency of flutter is a half integer multiple of rotational speed is studied. Two different instability mechanisms can be distinguished and are related to the two energy sources in the system, namely the rotation of a rotor and the forward speed of the helicopter. It is found that forward flight can have a significant stabilizing influence on flutter, and that as the tip speed ratio increases flutter occurs predominantly at half integer frequencies. The results are confirmed by the use of a numerical method. Author (ESRO)

N68-34046# McDonnel-Douglas Co., Santa Monica, Calif. Douglas Missile and Space Systems Div.
THE EFFECT OF GASEOUS INJECTION ON THE AERODYNAMICS OF TRANSPIRATION-COOLED HYPERVELOCITY BODIES
G. R. Inger and S. Sayano Aug. 1968 26 p refs Presented at the ASME Ann. Aviation and Space Conf., Beverly Hill, Calif., 16–19 Jun. 1968
(Douglas Paper-4883)

An approximate analysis is presented for the effect of arbitrarily distributed blowing on the laminar boundary layer flow and pressure distribution around two-dimensional or axially symmetric hypersonic blunt bodies. The analysis is based on a simplified integral method solution coupled with a Newtonian model of the inviscid flow around the effective body shape defined by the dividing streamline between the blown and free stream gas. Numerical results for a hemispherically blunted cone with various injection levels are given for three different types of blowing distributions encountered in practice. Significant increases in the local pressure are found when blowing is continued around the nose in the afterbody region. Author

N68-34091*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF THE DYNAMIC RESPONSE OF A SUPERSONIC MIXED-COMPRESSION INLET
Joseph F. Wasserbauer and Ross G. Willoh Washington 1968 13 p refs Presented at the 4th Propulsion Joint Specialist Conf., Cleveland, 10–14 Jun. 1968; Sponsored by AIAA
(NASA-TM-X-52441) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Details are given on a supersonic wind tunnel investigation of the dynamic response of an isolated inlet coupled to short and long cold-flow pipe configurations and for the inlet coupled to an operating turbojet engine. The isolated inlet and the inlet-engine configurations were subjected to an internal disturbance at frequencies up to 240 Hz and external disturbance at frequencies up to 15 Hz. A description of the inlet dynamic behavior is presented which combines a linearized set of equations across the shock with a relatively exact solution of the subsonic duct wave equations. Data from a digital computer solution of the equations for the inlet frequency response are presented. Dynamic response of the shock position resulting from a symmetrical internal disturbance showed that: (1) Resonance was observed at about 55 Hz. (2) The additional volume of the inlet configuration with the internal flow choked at the model exit resulted in a more rapid decrease in amplitude ratio. (3) Dynamic response of the shock position to an external disturbance was nonresonant over the test frequency range for the inlet-engine configuration. B.S.D.

N68-34188# National Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).
COMPARATIVE EXAMINATION OF EXISTING PROGRAMS FOR CALCULATION OF EXTERNAL FLOW-FIELDS FOR ELDO-A
C. R. Traas 19 Feb. 1968 59 p refs Prepared for ELDO
(NLR-TR-68009-U) CFSTI: HC$3.00/MF$0.65

A comparative study has been made of the methods and programs for the calculation of external flow-fields that are available to the various groups connected with the ELDO program. Recommendations are made for a selection from the presently existing programs, so that flow-fields can be predicted in an advanced and complete way. Author (ESRO)

N68-34191# Rome Univ. (Italy). Scuola di Ingegneria Aerospaziale.
AERODYNAMIC PROBLEMS WITH THE SAN MARCO 2 [PROBLEMI AERODYNAM ICI DEL SAN MARCO 2]
Carlo Buongiorno Jun. 1967 11 p refs In ITALIAN; ENGLISH summary *Its* Atti del Centro Ric. Aerospaziali 15-e
CFSTI: HC$3.00/MF$0.65

The determination of the drag coefficient for the scientific equatorial satellite San Marco 2 is dealt with. Author (ESRO)

N68-34258# National Physical Lab., Teddington (England). Aerodynamics Div.
COMPARATIVE THEORETICAL CALCULATIONS OF FORCES ON OSCILLATING WINGS THROUGH THE TRANSONIC SPEED RANGE
H. C. Garner and Doris E. Lehrian 22 Aug. 1967 79 p refs Supersedes NPL-AERO-MEMO-2; ARC-23917
(NPL-AERO-1246; ARC-29367; NPL-AERO-MEMO-2; ARC-23917) CFSTI: HC$3.00/MF$0.65 (See N68-18472)

Numerous linearized theories are applied to plunging and pitching rectangular, delta and symmetrical tapered wings in subsonic, sonic and supersonic flow. Pitching moments presented as continuous curves against Mach number for fixed frequency parameter. General theories are appraised beside exact theories for particular wings. Comparisons with experiment are satisfactory, except in transonic flow where uncertain wall interference masks the true discrepancies. Author (ESRO)

N68-34259# National Physical Lab., Teddington (England). Aerodynamics Div.
RECENT RESEARCH AT NPL ON SUPERSONIC AERODYNAMICS
P. G. Pugh, M. J. Larcombe, and L. C. Ward 5 Apr. 1968 25 p refs
(NPL-AERO-NOTE-1067; ARC-30104) CFSTI: HC$3.00/MF$0.65

This paper describes recent detailed studies of supersonic flow fields. Three major topics are discussed: (1) the minimization of forebody drag, (2) the lift and stability of delta wings and conical bodies, and (3) boundary layer transition. The relevance of this work to the aerodynamics of weapons is indicated. Author (ESRO)

N68-34347*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ANALYSIS OF BLADE-MOTION STABILITY FOR AN ARTICULATED ROTOR

Julian L. Jenkins, Jr. [1968] 8 p refs Presented at the 24th Ann. Natl. Forum of the Am. Helicopter Soc., Washington, D. C., 8–10 May 1968
(NASA-TM-X-61218) CFSTI: HC$3.00/MF$0.65 CSCL 01A

The blade-motion stability of a fully articulated rotor (i.e., flapping and lead-lag degrees of freedom) is evaluated using a numerical solution to the coupled, nonlinear equations of motion. Two effects of initial conditions on the tip speed ratio for divergence are indicated by varying the initial azimuth position for introducing a disturbance and by varying the disturbance amplitude at the critical azimuth angle. Methods of extending the divergence boundary of an articulated rotor are examined. The effects of hinge restraint (e.g., spring and damping) and flapping hinge cant angle δ_3 are evaluated individually and a representative combination of these parameters was chosen to indicate the overall effect on blade-motion stability. Author

N68-34349# National Physical Lab., Teddington (England). Aerodynamics Div.
HEAT TRANSFER AND TRANSITION MEASUREMENTS AT M=8.5 ON A DELTA MODEL AND A FLAT PLATE AT INCIDENCE
J. L. Wilson, L. Pennelegion, R. F. Cash, and M. J. Shilling 4 Mar. 1968 41 p refs
(NPL-AERO-1259; ARC-29986) CFSTI: HC$3.00/MF$0.65

The measurements were made on a 75°58' swept delta model and a 20° wedge in a shock tunnel. Local Reynolds number varied between 1.3×10^5 and 2.1×10^6. Transition was deduced from heat-transfer rate measurements and began at local Reynolds number down to 6.0×10^5 on the delta model. Comparison was made with other data. Author (ESRO)

N68-34398*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Florida Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING, PART 9 Final Report
R. W. Rockenbach 26 Sep. 1968 94 p
(Contract NAS3-7603)
(NASA-CR-54553; PWA-FR-2269, Pt. 9) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Three slotted rotors and three slotted stators with design diffusion factors in the range 0.5 to 0.7 were tested to determine the effect of the slots on performance. The slots reduced blade element losses in the midspan region without affecting deviation angle, and a small increase in unstalled operating range was noted. All blade rows tested showed strong wall stall, and no beneficial effect was noted from the slots in this region. It is hypothesized that slots must be located nearer to the leading edge in this region to be effective. Author

N68-34491*# Purdue Univ., Lafayette, Ind.
AN EXPERIMENTAL INVESTIGATION OF THE AERODYNAMIC FORCE CHARACTERISTICS OF A JET ISSUING TRANSVERSE TO A WEDGE Final Report
William L. Allen Jan. 1968 145 p refs Prepared in cooperation with Purdue Res. Found.
(Grant NsG-592)
(NASA-CR-96722; F-68-1; JPC-444) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Consideration is given to the aerodynamic interaction of a sonic jet issuing from a 15° wedge with a transverse supersonic stream which produces a side force due to flow interaction in addition to the jet thrust. In order to define the effects of the secondary flow parameters prior to combustion an investigation was conducted which was comprised of two phases: (1) an investigation of the flow field produced by the interaction of an inert gas injected through the surface of a wedge, and (2) a similar investigation with combustible injectants. Details are given on the experimental conditions and apparatus which consisted of two-dimensional supersonic wind tunnel and wedge model inserted into the exit stream of the tunnel. Experimental data are discussed in relation to shadowgraph pictures of the flow field and surface pressure distributions on the wedge model. The results, which are compared with previous flat plate experiments, show a more abrupt separation ahead of the slot, a shorter separation region and thicker boundary layer or wake downstream of the reattachment point. B.S.D.

N68-34650# Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.
A MODAL FORMULATION OF THE SUBSONIC TRANSIENT FLUTTER PROBLEM
B. Stahl Jun. 1968 47 p refs
(Douglas Paper-5059)

A rigorous modal formulation of the transient flutter problem based upon incompressible strip theory is derived. The derivation is unique in that it accounts for the spanwise variation of the lift buildup in a complete modal formulation of the problem. The usefulness of the method lies in its ability to predict meaningful values of the transient decay coefficient for purposes of wind tunnel and flutter flight testing. A technique for constructing the stiffness and equivalent viscous damping matrices by means of a generalized inverse is also given. An illustrative flutter analysis is made to demonstrate the method. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N68-33632# Standard Research Inst., Menlo Park, Calif. Sensory Sciences Research Center.
COMPARISONS BETWEEN SUBJECTIVE RATINGS OF AIRCRAFT NOISE AND VARIOUS OBJECTIVE MEASURES
Michael H. L. Hecker and Karl D. Kryter Apr. 1968 88 p refs
(Contract FA-67-WA-1696)
(FAA-NO-68-33)

Various established and proposed objective methods of measuring aircraft noise were evaluated with respect to their ability to predict subjective ratings of the acceptability of noise produced by present-day commercial aircraft. Recorded flyovers of several types of aircraft during takeoff and landing operations were selected, and other flyovers were electronically simulated. Paired-comparison listening tests were used to determine the level at which each flyover was considered to be as acceptable as a reference sound. Objective measures corresponding to this level were computed for each flyover. The relative accuracy with which the objective measures predicted the subjective ratings was expressed in terms of the variance in the computed values of each objective measure. The smallest variance was associated with a measure that takes into account the spectral properties of a given flyover for its entire duration and also the presence of pure tones or other narrow-band energy concentrations. Author

N68-33633# Wyle Labs., Inc., Huntsville, Ala.
SUBJECTIVE EVALUATION OF GENERAL AVIATION AIRCRAFT NOISE

J. B. Ollerhead Apr. 1968 102 p refs
(Contract FA-67-WA-1731)
(FAA-NO-68-35)

An experiment was conducted, in a progressive wave field, in which a group of subjects evaluated the noisiness of recorded general aviation aircraft sounds in comparison to jet transport flyover noise. The aircraft studied were piston engined, turboprop and turbojet aircraft in the weight range 2000 to 13,000 lbs. Twenty-eight noise rating scales were evaluated and it was found that of currently used scales, Perceived Noise Level, corrected for pure tone content, gave the best correlation with the subjective results. For the signals studied, duration appeared to have little influence on the subjective noisiness of flyover sounds. By comparing the results for a number of simulated flyover sounds it was concluded that an explanation lies in the influence of the Doppler frequency shift, which tends to cancel the effects of duration. A Doppler correction for current noise rating methods is presented which generally improves their correlation with observed results. Author

N68-33634# National Transportation Safety Board, Washington, D. C.
U.S. AIR CARRIER ACCIDENTS Annual Review, Calendar Year 1966
Dec. 1967 75 p
(PB-177599)

The report presents a record of aircraft accidents, incident to flight, which occurred in U.S. Air Carrier operations during the calendar year 1966. It includes a statistical recapitulation of all accidents, and a brief of each accident containing the essential items of information which fulfill the requirements of the majority of persons using these reports. Public reports containing greater detail have been issued by the Board on a number of the major accidents included in this report and are available upon request. In all cases, factual data obtained in the investigation may be released to inquirers at their expense when the reproduction of records is involved. Included in this report are five accidents still under investigation. Author (USGRDR)

N68-33643# Naval Air Test Center, Patuxent River, Md. Flight Test Div.
GUIDELINES FOR WITNESSING STRUCTURAL DEMONSTRATIONS OF NAVAL AIRCRAFT
Jack L. Holcomb 18 Jun. 1968 14 p refs
(TM-1-68; AD-671880)

The basic purpose of the structural demonstration is to verify that the airplane can be safely operated by Navy pilots during trials to limits consistent with the contract design limits for the airplane. In a broader sense, the structural demonstration provides the Navy with proof that the airplane is structurally capable of performing maneuvers which might be required in fleet use to perform its mission under the most severe conditions. Maneuvers, rate of control displacement, configurations, etc., should be representative of the most critical operational conditions. Author (TAB)

N68-33644# Battelle Memorial Inst., Columbus, Ohio.
POTENTIAL APPLICATION OF THE HELICOPTER IN URBAN MASS TRANSPORTATION
J. P. Loomis Oct. 1967 14 p *Its* Monograph-18
(Contract H-778)
(PB-178258) CFSTI: HC $3.00/MF $0.65

In the first part of this monograph, the current feasibility of VTOL type machines in intraurban transportation is briefly explored. It is shown that at 50 percent load factors, the helicopter could economically compete with taxicabs for stage lengths of 10 or more miles. The seat-mile costs for such stage lengths would be about $0.34 per occupied seat mile. However, it is observed that the helicopter would not enjoy the operational fluidity of a taxi, but would likely be restricted to certain high-density, point-to-point routes. This, together with current noise levels and the disruptions often caused by weather, seems to rule the helicopter out as a mass transportation device. A rather cursory examination of the effects of future research and development on VTOL feasibility is also made. Economically, it might be possible to reduce seat-mile costs by as much as 30 percent. Using the 50 percent load factor case again, and assuming 1967 dollar values, the helicopter could compete with taxicabs (in some respects) over routes as short as 5 miles. However, even these rates are not likely to permit the VTOL machine to serve in the role of mass transportation. Apart from economics the noise problem, air-traffic-control requirements with numerous vehicles in operation, and the effects of weather almost certainly preclude VTOL in the mass transportation role. Author (USGRDR)

N68-33645# Boeing Co., Wichita, Kans.
ELECTRICAL SYSTEM SELF TEST TECHNOLOGY
J. B. Soucek 22 Jan. 1968 27 p refs
(D3-7645; AD-671563)

The report evaluates the adequacy of self test concepts for the Trip Signal Indicator, MADREC and Built-In-Test-Equipment of the B-52 Electrical Generating System. The need for new self test methods is investigated and the design philosophy and criteria for an airborne data acquisition system is determined. Author (TAB)

N68-33646# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
AERODYNAMIC CHARACTERISTICS OF A GENERAL TILT WING/PROPELLER MODEL TESTED AT SLOW SPEEDS AND HIGH ANGLES OF ATTACK Final Report
Joseph James Traybar Feb. 1968 90 p refs
(Contract DA-44-177-AMC-8(T))
(USAAVLABS-TR-67-79; Rept.-807; AD-671666)

The aerodynamic characteristics of a general tilt-wing/propeller model were investigated at the Princeton Dynamic Model Tract Facility. The experiments included test conditions corresponding to free-stream velocities from slow backward flight through hovering and transition. Wing incidence angles ranging from 30 degrees (forward flight) to 90 degrees (hovering flight) were investigated. The experimental data are presented in graphs of lift, horizontal force, and pitching moment versus thrust in coefficient form based on free-stream velocity. Author (TAB)

N68-33647# Boeing Co., Morton, Pa. Vertol Div.
IN-FLIGHT MEASUREMENT OF ROTOR BLADE AIRLOADS, BENDING MOMENTS, AND MOTIONS, TOGETHER WITH ROTOR SHAFT LOADS AND FUSELAGE VIBRATION ON A TANDEM ROTOR HELICOPTER. VOLUME 5: INVESTIGATION OF BLADE STALL CONDITIONS Final Report
Richard R. Pruyn Apr. 1968 114 p refs
(Contract DA-44-177-AMC-124(T))
(D8-0382-5; USAAVLABS-TR-67-9E; AD-671665)

The report describes the results of an investigation into helicopter rotor blade stall conditions. The goals of this research were to increase the comprehension of blade stall and to aid in the future design of rotor blades with greater aerodynamic efficiency. The problem of rotor blade stall is discussed, covering areas such as rotor performance limitations, static airfoil section performance, dynamic and aerodynamic effects of the rotor environment, and radial flow effects. The results of the tests are presented and described in detail; they include tests at the high dynamic loads boundary, evidence of stall in rotor loads and blade motion data, coefficients of rotor airloads, and indications of negative aerodynamic damping. The test results are weighed against

theoretical methods of prediction for purposes of comparison. The use of airloads measurements in the synthesis of airfoil data is investigated and a method for doing so is provided. The conclusions drawn from these tests are presented and recommendations for future research in this field are given. Author (TAB)

N68-33648# Boeing Co., Morton, Pa. Vertol Div.
IN FLIGHT MEASUREMENT OF ROTOR BLADE AIRLOADS, BENDING MOMENTS, AND MOTIONS, TOGETHER WITH ROTOR SHAFT LOADS AND FUSELAGE VIBRATION, ON A TANDEM ROTOR HELICOPTER. VOLUME 4: SUMMARY AND EVALUATION OF RESULTS Final Report
Richard R. Pruyn Nov. 1967 285 p refs
(Contract DA-44-177-AMC-124(T))
(D8-0382-4; USAAVLABS-TR-67-9D; AD-671664)

The report describes and evaluates the results of an extensive program to measure the dynamic effects of flight on a tandem rotor helicopter. The flight test results are reviewed and then compared with theoretical predictions and with other flight test data. The airloads measurements from this program are similar to those of other flight test programs, with one major exception: single lifting-rotor helicopter data differ from the forward rotor data of a tandem. The aft rotor apparently produces an upwash which gives an increase in the airloads on the inboard region of the forward rotor. This effect results in an airload distribution that is similar to that which would be obtained with an increased blade twist of the forward rotor. For most longitudinal cyclic trim settings, the oscillations of the airloads of both tandem rotors tend to be similar to those of a single rotor, with intrarotor tip vortex intersections causing the predominant disturbances. Longitudinal cyclic trim settings can be obtained experimentally with the tandem helicopter which cause large airload pressure oscillations due to the intersection of forward rotor blade vortexes by the aft rotor blades. These pressure oscillations occur rapidly and do not appear to increase blade stresses, rotor shaft loads, or airframe vibration. Author (TAB)

N68-33649# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
COMPARISON OF THEORETICAL AND EXPERIMENTAL MODEL ROTOR BLADE VIBRATORY SHEAR FORCES
Lawrence J. Bain Oct. 1967 306 p refs
(Contract DA-44-177-AMC-136(T))
(SER-50419; USAAVLABS-TR-66-77; AD-671669)

An investigation was undertaken to obtain quantitative measurements of the vibratory forcing functions from the blades of rotary wing aircraft in the flight speed range encompassing both pure and compound helicopter operation. These measurements were made using dynamically scaled model rotor blades mounted on a specially instrumented rotor head. Testing was accomplished over a range of equivalent forward speeds from 75 to 300 knots and over a range of full-scale rotor lifts from zero to 40,000 lb. In addition to rotor performance, the final data include ten harmonics of the orthogonal blade root shear forces, rotor blade bending moments, and rotor control loads. A portion of the experimental results was correlated with a fully coupled aeroelastic analysis which included the effects of wake induced velocities. It was found that the inclusion of these effects improved the correlation of the flatwise shear forces over that obtained assuming uniform inflow. Author (TAB)

N68-33662# Picatinny Arsenal, Dover, N. J. Plastics and Packaging Lab.
SHIELD FOR PROTECTING PASSENGERS AGAINST SIDE EFFECTS OF EXPLOSIVE EXIT IN AIRCRAFT
Charles E. Yearwood and Joseph E. Gulbierz Jul. 1968 24 p
(PA-TM-1821; AD-671629)

Several protective shields differing in basic configuration, reinforcement, resin system, and method of attachment to the aluminum 'skin' were designed, fabricated, and evaluated. Their purpose was to provide protection against pressures generated and fragments produced as the result of the detonation of a linear-shaped charge installed against the side of an aircraft. One shield has been tested on the Convair 880. Author (TAB)

N68-33663# Army Aviation Materiel Labs., Fort Eustis, Va.
DEVELOPMENT AND TEST OF AN AUTOMATIC SHUTOFF CLOSED CIRCUIT REFUELING SYSTEM FOR THE UH-1 HELICOPTER Final Report
Francis V. Limandri and Leonard M. Bartone Mar. 1968 39 p
(USAAVLABS-TR-68-37; AD-671645)

An in-house program was conducted to derive a method for rapid refueling of Army helicopters. The objective was to devise a system which would permit refueling of helicopters while engines and rotors were operating without the risk of fuel contamination or the hazard of fire. A closed system utilizing a dry-break coupling between fuel hose nozzle and aircraft was deemed to offer potential. Experimental models were fabricated and tested and modifications were made to the models in areas where test results indicated that deficiencies existed. Tests and modifications continued until design characteristics for a prototype model were finalized. Design characteristics are as follows: (1) automatic-shutoff device, (2) quick-connect/disconnect dry-break coupling between aircraft adapter and nozzle, (3) conventional refueling capability, (4) simplified system for field retrofit. Ten prototype units were fabricated for military potential test purposes. The tests showed that the automatic-shutoff closed-circuit refueling system has military potential and will meet the program objective. It is concluded that the effectiveness of helicopters as assault vehicles can be improved through the use of this system. Author (TAB)

N68-33664# Boeing Co., Wichita, Kans.
HYDRAULIC SYSTEM SELF TEST TECHNOLOGY
Rodney D. Crampton 2 Feb. 1968 25 p
(D3-7639; AD-671562)

The document contains the results of a study conducted by Boeing-Wichita for detection of aircraft hydraulic system performance degradation and identification of problem areas. Author (TAB)

N68-33669*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF SPEED BRAKES ON THE SUPERSONIC AERODYNAMIC CHARACTERISTICS OF A VARIABLE SWEEP TACTICAL FIGHTER MODEL AT MACH NUMBERS FROM 1.60 TO 2.50
Celia S. Richardson Washington Sep. 1968 35 p refs
(NASA-TN-D-4773) CFSTI: HC $3.00/MF $0.65 CSCL 01B

An investigation has been made in a wind tunnel to determine the effect of various speed-brake configurations on the aerodynamic characteristics of a current multimission tactical fighter model. The speed-brake configurations, which included upgapped and gapped brakes with variations in area, location, planform, and deflection angle, were tested at Mach numbers from 1.60 to 2.50 for a wing-leading-edge sweep angle of 72.5°. Tests were made through an angle-of-attack range from about −4° to 28° and at angles of sideslip from about −6° to 11°. The test Reynolds number was 3.0×10^6 per meter). The results indicated the drag values of a gapped and an ungapped brake configuration were about the same; even though the gapped speed brakes were somewhat smaller then the ungapped brakes. The ungapped speed brakes generally increased the directional stability of the model. The gapped speed brakes generally reduced the directional stability of the model particularly at the higher test Mach numbers. Author

N68-33670# National Defense Research Organization TNO, the Hague (Netherlands). Medical Biological Lab.
REPORT ON BIRD STRIKES [RAPPORT INZAKE VOGELAANVARINGEN]
O. Vos and R. A. Oosterbaan May 1968 9 p refs In DUTCH; ENGLISH summary
(MBL-1968-6; A68/KLU/011; TDCK-51233/II/) CFSTI: HC $3.00/MF $0.65

Microscopic and biochemical investigations were carried out on a few parts of an engine from a crashed jet fighter. No morphological or biochemical indications of remnants of birds could be detected. Due to lack of experience with this type of investigation, the possibility of a bird strike could not definitely be excluded. It is concluded that the chemical and microscopical investigations as described in the Canadian reports can make an important contribution to the detection of a bird strike. However, it seems necessary to acquire more experience before a definite evaluation of the method can be given. Author

N68-33671# Oceanics Inc., Plainview, N. Y.
MODEL STUDIES OF HELICOPTER ROTOR FLOW PATTERNS Final Technical Report
August F. Lehman Apr. 1968 122 p refs
(Contract DA-44-177-AMC-426(T))
(USAAVLABS-TR-68-17; TR-67-38; AD-671670)

The report discusses an experimental program undertaken in a water tunnel wherein the tip vortex patterns were made visible through air bubble injection at the rotor tips. The model was a scaled version of the 48-foot-diameter Bell UH-1D rotor. The rotor configuration was tested as a standard 2-bladed unit and also as a 1- and 3-bladed unit. Correlation was established by comparing full-scale vertical lift values (at hover conditions) with scaled model values, where the model was mounted above the tunnel floor at a distance equivalent to out of ground effects for the full-scale vehicle. Employing solely a Prandtl-Glauert correction factor produced excellent lift value agreement between the model and the full-scale vehicle. Different aspects of the tip vortex patterns were visible from 2 to 6 diameters downstream; thus the technique appears promising for both near and far field studies. High speed movies and stop and time exposure photographs were used to document the variation in vortex patterns. Discrete tip vortex patterns are created for forward flight regimes in the general ranges of hover to 10 knots, 10 to 50 knots, and above 50 knots. Tip vortices shed from one blade do intersect with following blades (under certain conditions), thus verifying a limitation in the commonly employed mathematical models, where this limitation has been hypothesized by certain other investigators. Author (TAB)

N68-33672# Aircraft Armaments, Inc., Cockeysville, Md.
40,000 POUND-CAPACITY HEAVY-LIFT HELICOPTER EXTERNAL CARGO HANDLING SYSTEM DESIGN STUDY Final Report
Robert V. Patterson, Fred J. Fisch, Hans D. Heyck, Richard L. Jarvis, and Barron W. Mouring Apr. 1968 147 p refs
(Contract DA-44-177-AMC-968(T))
(ER-4510K; USAAVLABS-TR-68-16; AD-671674)

The purpose of this program was to design a helicopter hoist system capable of lifting 40,000 pounds. Desired features of the hoist system included a weight limitation of 4,000 pounds and the ability to provide either a 1- and 2-point load suspension system or a 1- and 4-point load suspension system. Major areas of investigation included a study of primary tension members; the relative advantages of multi-drum and single-drum hoist systems; single wrap and overlaying of cables on hoist drums; and the desirability of including vibration isolation components between the external load and the helicopter. Through study and tests, it was determined that it was possible to provide a combined system which permits 1-, 2-, and 4-point load suspension. This feature is achieved by use of a single cable drum winding four separate cables. Varying the method of reeving the cables permits the selection of either a 1-, 2-, or 4-point load suspension system. Load attitude and cable loading may be adjusted by means of four hydraulic control cylinders included in the system. Using a single drum with four cables eliminates the complex synchronization problems associated with a multi-drum drive system. Author (TAB)

N68-33673# Naval Air Development Center, Johnsville, Pa. Aero Materials Dept.
DEVELOPMENT OF A CORROSION CONTROL TOUCH-UP KIT FOR INDIVIDUAL AIRCRAFT
A. J. Koury Dec. 1967 26 p refs
(NADC-MA-6731; AD-671812)

A Corrosion Control Touch-Up Kit was developed in order to provide fleet activities with equipment and materials to counteract corrosion on aircraft surfaces as soon as detected, thus providing a means whereby aircraft many remain in service until the next scheduled PAR. The kit described herein is considered satisfactory by the fleet and the Naval Air Systems Command. Author (TAB)

N68-33675# EDO Corp., College Point, N. Y.
SURVEY ON SEAPLANE HYDRO-SKI DESIGN TECHNOLOGY. PHASE 2: QUANTITATIVE STUDY
Perry A. Pepper and Leon Kaplan 28 Mar. 1968 245 p refs
(Contract N00014-66-C-0126)
(Rept.-7489-2; AD-671930)

The report covers the second part of a two-phase survey and analysis of hydro-ski seaplane technology. It contains quantitative correlations and parametric analyses of significant data used to define optimum hydro-ski size, ski location with respect to the strut and aircraft, ski and strut resistance, ski loads and load factors in waves, strut attachment to the aircraft, effects of strut size and length, and ski installation weight. Author (TAB)

N68-33676# Lockheed-Georgia Co., Marietta.
PRELIMINARY INVESTIGATION OF TROLLEY LOW ALTITUDE AIRCROP CONCEPT
C. W. Miller, D. E. Alford, H. E. Komodowski, and F. G. Stokes Natick, Mass. Airdrop Eng. Lab. Apr. 1968 202 p refs
(Contract DA-19-129-AMC-856(N))
(TR-68-55-AD; AD-671682)

The Lockheed Trolley Low Altitude Airdrop Concept employs a towed parachute to maintain tension in a long cable from which a load may be suspended until it contacts the ground. After it is extracted by the force of the parachute, the load slides beneath the cable until it contacts the ground. Rate of descent is controlled by a winch in the aircraft that reels in the cable as needed to minimize impact velocity. This preliminary concept-oriented investigation was undertaken to determine the feasibility of developing this system for operational use. The study consists of analytical evaluation of the operational parameters, limited component testing, and consideration of basic hardware requirements. Digital and analog computer simulations of Trolley airdrop are among the analytical methods employed. Two tests of a parachute towed on a Trolley cable behind a C-130 aircraft are evaluated. Laboratory tests of certain components are analyzed with respect to flight safety. Results of the study indicate no problems which preclude the development of the Trolley airdrop concept into an operational system for airdropping individual loads of 2,000 to 10,000 pounds from a C-130 below 500 feet. Comparison of Trolley to conventional airdrop shows: (1) costs are reduced, (2) accuracy is improved, (3) impact velocities are lower, (4) rigging is simplified. However, the system is unsuitable for mass assault where several unit loads must be dropped per aircraft pass. Author (TAB)

N68-33764# Boeing Co., Seattle, Wash. Flight Sciences Lab.
SOME OPEN QUESTIONS ON THE JET NOISE PROBLEM
J. E. Ffowcs Williams Jun. 1968 24 p refs
(D1-82-0730)

Mathematical descriptions of the sources of sound noise in jets at high and low Mach estimate the noise produced by jets at moderate speeds and the noise produced by combustion of excess fuel in the exhaust. The theory is then applied to high Mach number situations, where the results are inconclusive. Estimates of sources to be expected in moderate speed jets, issuing from a multitude suppressor, and in low speed jets, issuing from nozzle exit turbulence, are made. Author

N68-33833# National Aeronautical Establishment, Ottawa (Ontario).
DESCRIPTION OF A FOUR DEGREES OF FREEDOM, V/STOL AIRCRAFT, AIRBORNE SIMULATOR
D. F. Daw, K. Lum, and D. M. McGregor Feb. 1968 34 p refs
(NRC-10182; NRC-LR-499) CFSTI: HC 3.00/MF$0.65

A variable stability helicopter capable of altering its characteristics in the three rotational degrees of freedom as well as the heave or vertical degree of freedom was developed and utilized on a variety of V/STOL handling qualities research programs. The simulator systems are described and its capabilities are outlined. Author

N68-33872# Kaman Aircraft Corp., Bloomfield, Conn.
CABLE GUIDED WINCHDOWN LAUNCH-LAND EVALUATION OF THE UH-2 HELICOPTER, 1 FEBRUARY–29 MARCH 1967
P. J. DeCrisantis and G. P. Basile 15 Dec. 1967 126 p refs Revised
(Contract NOw-66-0499-f)
(T-486; AD-671895)

Cable-guided winchdown, ready-launch and on-deck topping operations were evaluated in the UH-2A/B helicopter and found to be feasible. Flight test data for cable-guided winchdown and ready-launch operations compared favorably with analytical predictions for land-based operations. The established correlations were subsequently used to predict ship based winchdown characteristics. Aircraft cable guided ascents and retrievals were made in winds up to 50 knots without difficulty. Smooth and positive lift offs were made by holding cable tension between 600 and 1000 pounds. A cable tension of 1000-1500 pounds generally resulted in smoother retrievals due to the ability to maintain steady cable load and rate of descent. The rate of descent considered most comfortable from the pilots standpoint was 150 ft./min. Static controllability was evaluated at cable angles up to 20 degrees longitudinally and laterally and at cable tensions from 500 to 2300 pounds. Control positions varied only 10 percent from trim for the various combinations of cable angles and cable tensions investigated, allowing ample control margins even at extreme conditions. The dynamic stability characteristics of the helicopter during winchdown operations are acceptable. Author (TAB)

N68-33875# Advisory Group for Aerospace Research and Development, Paris (France). Study Group on Flight Recording Systems for Military Operational Aircraft.
APPLICATION OF AIRCRAFT INTEGRATED DATA SYSTEMS
C. den Hertog Dec. 1967 111 p refs
(AGARD-561) CFSTI: HC$3.00/MF$0.65

The subject has been interpreted broadly to include all aspects of data acquisition, and to be synonymous with the term Aircraft Integrated Data Systems (AIDS). The processed data can be analysed and used in accident investigation, project design, airworthiness (including fatigue) studies, aircraft maintenance and mission performance assessment; a review is given of past activities, current requirements and future development in these fields. In the first three of these areas procedures are well-established and relatively simple instrumentation is available; in mission performance assessment and aircraft maintenance, however, AIDS have reached a less advanced stage, though great promise is shown. In general, it is concluded that, although a considerable range of techniques and equipment already exists, most are of an experimental nature and it is essential that equipment suppliers should continue to strive to reduce size, weight and cost while improving accuracy and reliability. Author

N68-33878*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SOME CONSIDERATIONS IN WIND-TUNNEL TESTS OF V/STOL MODELS
Harry H. Heyson 1968 62 p refs Presented at the Pa. State Univ. Aerodyn. of V/STOL Aircraft Seminar, University Park, Pa., 25–30 Aug. 1968
(NASA-TM-X-61167) CFSTI: HC$3.00/MF$0.65 CSCL 01C

Considerable care is required in applying wall interference corrections to V/STOL data. The following items comprise a minimum list of features which should be considered: type of tunnel and proportions, effective wake skew angle, span of both lifting system and tail, configuration, model location, tail length and height, angle of attack, pivot location, and center-of-gravity location. Auxilliary balances may be required to obtain the forces of each component in complex lifting systems. Some discrepancies may remain, largely because of the imperfect knowledge of the aerodynamics of many V/STOL configurations. The boundary layer on the tunnel floor requires careful consideration, particularly in ground-effect testing. Recirculation will limit the minimum speeds at which successful data can be obtained. Many questions, such as the effect of angular and velocity rates, remain to be answered in evaluating V/STOL testing techniques. Author

N68-33879*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FREE-FLIGHT AND WIND-TUNNEL STUDIES OF DEPLOYMENT OF A DYNAMICALLY AND ELASTICALLY SCALED INFLATABLE PARAWING MODEL
Alice T. Ferris and H. Neale Kelly Washington Sep. 1968 44 p refs
(NASA-TN-D-4724) CFSTI: HC$3.00/MF$0.65 CSCL 01A

The deployment characteristics of a 1/8-size dynamically and elastically scaled model of an inflatable parawing suitable for the recovery of an Apollo-type spacecraft were investigated in free flight and in the Langley transonic dynamics tunnel using a model which was mounted to permit limited angular freedom. The deployments were of a passive type; that is, there was no powered reel-in or reel-out of the suspension lines. However, a braking system was used to attenuate the dynamic loads in the suspension lines. The deployment technique was developed in an initial series of wind-tunnel tests. By utilizing the equipment and technique evolved from the wind-tunnel studies, successful free-flight deployments were accomplished and the transient loads associated with the deployments were measured. These results were compared with the results of subsequent wind-tunnel tests. The general behavior of the parawing during deployment in the wind tunnel and during free flight was similar and loads measured in the wind tunnel can be used to give a preliminary indication of those that will be encountered in free-flight deployments. Thus, it was concluded that the wind tunnel can serve as a useful tool in the development of a deployment technique for an inflatable parawing. Author

N68-33880# Department of Transportation, Washington, D. C. Office of Noise Abatement.
FEDERAL AIRCRAFT NOISE ABATEMENT PROGRAM

1 Apr. 1968 28 p
(PB-178329) CFSTI: HC$3.00/MF$0.65

A summary overview and a summary status are presented. The following recommendations are discussed: Analysis of the aircraft noise problem and formulation of appropriate alleviation program and guidance; Cost allocation; Noise measuring methods and evaluation techniques; Engine noise reduction; Landing approach procedures; Climb-out procedures; Compatible land use; Sound insulation of houses; Legislation. USGRDR

N68-33881# Mississippi State Univ., State College. Dept of Aerophysics and Aerospace Engineering.
DEVELOPMENT OF AN ENGINE-POWERED LIQUID DISPERSAL SYSTEM FOR AGRICULTURAL AIRCRAFT
Michael R. Smith, Robert E. Williamson, and A. Jack Garrett Jan. 1968 57 p refs
(Contract AF-66-WA-1531)
(FAA-DS-68-3; AD-671891)

The report presents the results of efforts to design, a liquid dispersal system for agricultural aircraft which would have low power requirements as compared to standard windmill powered pump systems. The resulting system consisted of a standard spray pump powered from the aircraft engine accessory pad and a spray boom mounted in the wing wake. The maximum power requirement of the final configuration was 12.5 brake horsepower at 100 miles per hour as compared to 52 brake horsepower for the standard system. Significant increases in climb performance and reduction of level flight power requirements were measured. No adverse effects on stall characteristics and control feedback were noted. Author (TAB)

N68-33882# Bunker-Ramo Corp., Canoga Park, Calif.
SUMMARY OF ALL WEATHER LANDING SIMULATION STUDIES Final Report
R. D. Monroe, D. Vreuls, and C. A. Semple Feb. 1968 60 p refs
(Contract FA-67-WA-1700)
(RD-68-13; AD-671803)

Six studies were conducted in a flight simulator in an effort to determine the essential characteristics of the cockpit displays required for Category III all weather landing operations. The first two studies, reported on an earlier contract, examined the utility of current flight directors for all-weather landing in a jet transport. The last four studies, covered by Contract FA67WA-1700, examined various display and control concepts. The report briefly summarizes all six studies, discusses the general results of the work and suggests areas for future study. Author (TAB)

N68-33902# Office of Research Analyses, Holloman AFB, N. Mex.
THE ARC HEATED THERMALJET ENGINE Final Report
Friedrich G. Penzig Mar. 1968 78 p refs
(ORA-68-0005; AD-671501)

The general aspects of the arc jet engine are discussed on the basis of work performed by Giannini and McDonnell prior to 1967. The basic performance equations for arc jet engines have been derived and used in a parametric study. The problem of an optimum specific impulse is treated in detail. Author (TAB)

N68-33903# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
THEORY AND IBM 360/75 DIGITAL COMPUTER PROGRAMS FOR RIGID-BODY TIME-HISTORY GUST-RESPONSE ANALYSIS
Dino George and George R. Schriro Jul. 1968 326 p refs
(FSR-AD6-03-68.2)

This report presents the theory and associated IBM 360/75 digital computer programs for obtaining longitudinal and lateral rigid-body responses due to atmospheric turbulence inputs in the time domain. The mathematical model used is a linear multi-degree-of-freedom second-order system of equations, in which the coefficients are evaluated using the airplane mass properties and aerodynamic stability derivatives. The specific modes of response for which subprograms are developed are longitudinal motion (vertical translation and pitch) and lateral motion (roll, yaw, and lateral translation). Auxiliary equations are provided for computing airplane angle of attack and cockpit normal acceleration associated with the longitudinal response and the effective lateral acceleration and the vertical tail load associated with the lateral response. Author

N68-33937 Institute for Defense Analyses, Arlington, Va. Program Analysis Div.
THE DEMAND FOR INTERCITY PASSENGER TRANSPORTATION BY VTOL AIRCRAFT. VOLUME 4: SPECIFIC AIRCRAFT DEMAND BY CITY PAIR
Norman J. Asher, Elliot Wetzler, Seymour M. Horowitz, and W. Bartz Schneider Aug. 1968 111 p
(R-144, V. 4; IDA-HQ-68-8875)

The demand for specific aircraft designs by city pair was calculated, and the results are presented in the form of a CDC 1604 computer printout. The results are for 86 city pairs for the tilt rotor, tilt wing, stowed rotor, and fan or jet lift aircraft since all of these aircraft types have a 500-mile design range and can fly all city pairs non-stop. Individual city pair regression equations were derived which make VTOL passenger demand after stimulation a function of fare and block time. The demand for helicopters and compound helicopters, with a design range of 250 miles, was determined by manual cross plotting. K.W.

N68-33938 Institute for Defense Analyses, Arlington, Va. Program Analysis Div.
THE DEMAND FOR INTERCITY PASSENGER TRANSPORTATION BY VTOL AIRCRAFT. VOLUME 3: GENERALIZED AIRCRAFT DEMAND BY CITY PAIR
Norman J. Asher, Elliot Wetzler, Seymour M. Horowitz, and W. Bartz Schneider Aug. 1968 205 p
(R-144, V. 3; IDA-HQ-68-8874)

Generalized aircraft demand by city pair is derived as a function of VTOL aircraft fare, block time, and number of seats. Ranges of VTOL block times and fares were assumed for each city pair, and the number of VTOL passengers before and after VTOL speed stimulation was calculated for each combination of fare and block time. Then for each fare and block time combination, the number of aircraft required to carry the VTOL passengers (after speed stimulation) was calculated for a variety of aircraft seating capacities. Associated daily round-trip frequencies are presented, and VTOL fares are compared with conventional takeoff and landing fares. For city pairs under 250 miles, four block times covering the range from helicopter to fan or jet lift block times were used. For city pairs over 250 miles, beyond the design range of the helicopter and compound helicopter, three block times covering the range from tilt rotor to fan or jet lift block times were used. All data and results are presented in the form of a CDC 1604 computer printout. The reference year for the estimations is 1965, and the projected years are 1975 and 1985. K.W.

N68-33939# Institute for Defense Analyses, Arlington, Va. Program Analysis Div.
THE DEMAND FOR INTERCITY PASSENGER TRANSPORTATION BY VTOL AIRCRAFT. VOLUME 2: APPENDICES

Norman J. Asher, Elliot Wetzler, Seymour M. Horowitz, and W. Bartz Schneider Aug. 1968 234 p refs
(R-144, V. 2; IDA-HQ-68-8873)

Separate, detailed studies are presented of factors affecting the overall demand and cost function estimates. The following are covered: (1) characteristics, costs, and load factors of aircraft; (2) calculation of aircraft fares, nonpassenger revenues, and rate of return on investment; (3) distributions of local origin and destination; (4) time and cost of ground transport to airport; (5) location and comparative cost estimates of vertiports and airports; (6) derivation of passengers' value of time relative to income, from the 1963 census of transportation; and (7) VTOL stimulation of air travel. K.W.

N68-33940# Institute for Defense Analyses, Arlington, Va. Program Analysis Div.

THE DEMAND FOR INTERCITY PASSENGER TRANSPORTATION BY VTOL AIRCRAFT. VOLUME 1: Summary and Method

Norman J. Asher, Elliot Wetzler, Seymour, M. Horowitz and W. Bartz Schneider Aug. 1968 84 p refs
(R-144, V. 1; IDA-HQ-68-8872)

Aircraft demand and cost functions were estimated for six types of VTOL aircraft: conventional helicopter, compound helicopter, tilt rotor, tilt wing, stowed rotor, and fan or jet lift. From these functions total aircraft profit or loss as a function of the number of aircraft produced was calculated. Results were calculated for the 90 seat size of all six types; in addition, 30, 60, 120, and 150 seat sizes were analyzed for the fan or jet lift type. The aircraft demand was calculated separately for each domestic city pair and then summed to obtain total domestic demand. The domestic demand was then increased by a constant ratio to account for export sales. Demand is based on air traffic for 1985, the estimated final year of production for these first generation intercity VTOL aircraft. Author

N68-34041# Boeing Co., Morton, Pa. Vertol Div.

IN-FLIGHT MEASUREMENT OF ROTOR BLADE AIRLOADS, BENDING MOMENTS, AND MOTIONS, TOGETHER WITH ROTOR SHAFT LOADS AND FUSELAGE VIBRATION, ON A TANDEM ROTOR HELICOPTER. VOLUME 3. DATA PROCESSING AND ANALYSIS SYSTEM Final Report

John W. Obbard Nov. 1967 119 p
(Contract DA-44-177-AMC-124(T))
(D8-0382-3; USAAVLABS-TR-67-9C; AD-671662)

An extensively instrumented tandem rotor helicopter was flight-tested to measure the rotor blade airloads and the resulting rotor blade motions and bending moments, rotor shaft loads and moments, and fuselage vibration. The voluminous output of this extensive instrumentation was processed by a fully automated data system which is described in the volume. Data were tape-recorded in sequenced-multiplexed, frequency-modulated (FM) form during flight testing. The FM signals were discriminated to analog form and were digitized by using a high-speed analog-to-digital converter. Digital data were calibrated, corrected for temperature and load interactions, and harmonically analyzed by using a series of digital computer programs. Airloads pressure data were numerically integrated to determine instantaneous blade section lift and pitching moment and the lift and pitching moment of the entire rotor blade. Data were also prepared for other analyses. The data system also included various data checks which are discussed. Substantiating tests and analyses that were performed to ensure the proper operation of this system are also presented. Data output from this program is available on a computer tape (nine-track, IBM System 360) in fully identified form for utilization in further analyses. Author (TAB)

N68-34148# Boeing Co., Seattle, Wash. Flight Sciences Lab.

VARIATION IN TORQUE FOR A ROTOR OPERATING IN AN OPEN-ENDED ENCLOSURE

Georg K. Timm Jul. 1968 19 p refs
(D1-82-0743)

Consideration is given to the problem of flow recirculation in an enclosed rotor test stand. Details are given on study which examined the influence an open-ended enclosure exerts on the torque required to operate a rotor close to the ground. The experimental equipment is discussed in relation to the rotor, ground plane and rotor driven mechanism, and torque meter. Twelve ring obstacles were placed on the ground plane concentric with the rotor shaft centerline and torque measurments were taken. Results show that the ring obstacles lead to appreciable variations in torque required, and that the reduction is dependent as well on the height of the enclosure as on the distance rotor disk plane to ground plane. B.S.D.

N68-34173# Royal Aircraft Establishment, Farnborough (England).

A FLIGHT EXPERIMENT TO MEASURE THE PERFORMANCE OBTAINED FROM TWO MODIFIED GLIDE-PATH CONTROL LAWS IN THE Mk.10B AUTOPILOT

G. P. Lazenby Dec. 1967 43 p refs
(RAE-TR-67325) CFSTI: HC $3.00/MF $0.65

Flight experiments to show the improvement in performance which can be obtained when extra terms, including inertial, are added to the glide-path control law of a Mk.10B autopilot are described. Author (ESRO)

N68-34314*# Stanford Research Inst., Menlo Park, Calif.

SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 2: IMPACTS UPON AVIATION AND AERONAUTICS

John Baird and Virginia F. Holley Jun. 1968 38 p refs
(Contract NASw-1722; SRI Proj. MU-7227)
(NASA-CR-96810) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Highlights of the NASA aeronautical research program as presented by NASA and as presented to the public through the trade and news press are reviewed here. We find that while the research and development effort is eminently successful and current as shown by the technical quality and competitive position of U.S. aeronautical equipment, the NASA effort is never presented in a positive light when the message is directed at the general public, nor is it complete when directed toward the technically oriented community. Since the NASA aeronautical activity is not separated from operational vehicles by more than a few years, direct economic benefits that pay for all of the NASA aeronautical research can be pointed out. Also, since the technology is not far in advance of its application, the new jobs resulting from improvements can be identified; opportunity exists to train the surplus labor (hard core unemployed) for the jobs. These and other benefits are described in some detail. On the other hand, there are indications that the lead in aeronautical research NASA once had is gone; in fact, some valuable break-throughs are late. It is also indicated that the advanced programs are important in maintaining a research lead. Author

N68-34327# Interior Dept., Washington, D. C. Wildlife Research Div.

ESTABLISHING CERTAIN PARAMETERS OF HAZARDS TO AIRCRAFT BY MIGRATING BIRDS IN THE MISSISSIPPI FLYWAY Interim Report

Frank C. Bellrose (Ill. Univ., Urbana) Nov. 1967 84 p refs
Prepared for FAA
(FA-65-WAI-77)
(RD-67-67)

The Mississippi Flyway receives the heaviest waterfowl traffic in the United States. This report is primarily concerned with this flyway; however, several important routes leading to the Atlantic Flyway cross the Mississippi Flyway, requiring that some treatment of the Atlantic Flyway be included. The routes used by migrating waterfowl are mapped for dabbling ducks, diving ducks, Canada geese, and blue and snow geese. The volume of waterfowl traffic is delineated where possible. Most waterfowl migrate at night and at relatively low altitudes, thereby reducing the potential hazard to aircraft. Knowledge of the altitudes utilized by migrating waterfowl offers a means of reducing the bird strike potential through changes in altitude assignments. Waterfowl passage is greatest following cold fronts in fall, especially between mid-October and December, and following warm fronts in the spring, especially between March 1 and April 10. Author

N68-34348*# National Aeronautics and Space A ministration. Langley Research Center, Langley Station, Va.

FLIGHT INVESTIGATION OF THE WING-ROTOR LIFT-SHARING CHARACTERISTICS OF A HINGELESS ROTOR COMPOUND HELICOPTER

Perry L. Deal and Julian L. Jenkins, Jr. [1968] 5 p refs Presented at the 24th Ann. Natl. Forum of the Am. Helicopter Soc., Washington, D. C., 8–10 May 1968

(NASA-TM-X-61219) CFSTI: HC$3.00/MF$0.65 CSCL 01C

The results of an NASA flight test program utilizing the Army/Lockheed hingeless rotor compound aircraft to determine the lift sharing characteristics of the wing and rotor in both level and maneuvering flight are presented. The data show that there is an inherent reduction in rotor lift as level flight airspeed is increased. This reduction in rotor life provides a margin between the trim lift in level flight and the maximum lifting capability of the rotor which may be utilized in maneuvers. In addition, the measured reduction in rotor-lift sensitivity in accelerated flight which occurs with increasing speed helps to alleviate the rotor stall problems. Although the load-sharing trends contribute favorably to the piloting task in the compound mode, the rotor overspeed tendencies could require constant attention during maneuvering flight. Author

N68-34364# National Bureau of Standards, Washington, D. C. Fire Research Section.

SMOKE AND GASES PRODUCED BY BURNING AIRCRAFT INTERIOR MATERIALS Final Report

D. Gross, J. J. Loftus, T. G. Lee, and V. E. Gray Jun. 1968 90 p refs

(Contract FA-66-NF-AP-7)

(NA-68-36; DS-68-16)

Measurements are reported of the smoke produced during both flaming and sm exposures on 141 aircraft interior materials. Smoke is reported in terms of specific optical density, a dimensionless attenuation coefficient which defines the photometric obscuration produced by a quantity of smoke accumulated from a specimen of given thickness and unit surface area within a chamber of unit volume. During the smoke chamber tests, indications of the maximum concentrations of CO, HCl, HCN and other selected potentially toxic combustion products were obtained using commercial colorimetric detector tubes. A study was made of the operation, accuracy and limitations of the detector tubes used. Measurements of the concentrations of HCl were also made using specific ion electrode techniques. The elevated temperature thermal degradation of selected materials was studied in a number of ways including thermogravimetry and differential scanning calorimetry. Qualitative identification of the major components of the original test materials was accomplished primarily by infrared absorption spectrophotometry. Author

N68-34432*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

RECENT RESULTS OF SONIC BOOM RESEARCH

Harvey H. Hubbard May 1968 25 p refs Presented at the AFOSR–UTIAS Symp. on Aerodyn. Noise, Toronto, 20–21 May 1968

(NASA-TM-X-61240) CFSTI: HC$3.00/MF$0.65 CSCL 01B

A state-of-the-art review of sonic boom technology emphasized the physical aspects of the problem, including exposure pattern development, propagation through an inhomogeneous atmosphere, and effects on structures and people. Building vibration responses that involve structural-air cavity coupling were found to be an important factor in subjective responses, and sonic boom wave shape was also found to be important. Seismic responses were shown to be predictable and a function of both the aircraft operating conditions and the local geological environment. M.W.R.

N68-34571*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SOME RECENT INFORMATION ON AIRCRAFT VIBRATION DUE TO AERODYNAMIC SOURCES

Harry L. Runyan [1968] 36 p refs Presented at the Acoust. Soc. of Am. Meeting, Ottawa, 21–24 May 1968

(NASA-TM-X-61206) CFSTI: HC$3.00/MF$0.65 CSCL 01C

Aerodynamically induced vibration problems of aircraft are reviewed, emphasizing boundary layer noise, buffet, gust response, canard buffet, flutter, sonic fatigue, and helicopter vibration. Author

N68-34610# Parks Coll. of Aeronautical Technology, East St. Louis, Ill.

A COST-EFFECTIVENESS ANALYSIS COMPARING REBUILD AND OVERHAUL MAINTENANCE POLICIES FOR ARMY AIRCRAFT DYNAMIC COMPONENTS

Sep. 1967 155 p refs

(Contract DA-23-204-AMC-04373(T))

(USAAVCOM-TR-67-11; AD-672096)

The purpose of this study was to compare the restoration policies of rebuild or overhaul to determine which is more economical. A mathematical model was used that incorporates only those costs which show a significant difference between an overhaul and rebuild restoration policy and that incorporates only those variables which are judged to have a significant impact on the model output. The data used to derive these results was obtained almost entirely from Department of the Army records through AVCOM. Once the data had been substituted for the variables in the model, a computer program was written. A sensitivity analysis was then developed and applied to each of seven independent variables. Finally, a consideration of the effect of government furnished materiel as opposed to contractor furnished materiel on total cost of a rebuild or overhaul restoration policy was made. Author (TAB)

N68-34739# LTV Aerospace Corp., Dallas, Tex. Aeronautics Div.

DETERMINATION OF CHARACTERISTIC NON-DIMENSIONAL LOAD STROKE DIAGRAMS FOR SHIPBASED AND SHOREBASED CATAPULTING AND ARRESTING GEAR FROM ANALYSIS OF AIRPLANE AND DEAD LOAD TEST DATA, APPENDICES A AND B Final Report

1 May 1968 195 p

(Contract NOw-66-0290-c)

(Rept.-2-53470/6R2259; APP.; AD-672550)

The results of the analysis performed on the sub-capacity catapult test data during this program are presented in concise non-dimensional form (as well as other forms) suitable for

incorporation as input data into analytical simulations of aircraft launching operations. Descriptions of the forces imparted to aircraft during launching operations from the more recent shipbased steam catapult are given. Fluctuations in loads, accelerations, velocities, etc., based on a probability of occurrence, are given. During the statistical analysis, tests were made to determine if normality of distribution existed for the variables under consideration. The tests showed either that normality does exist or that the assumption of normality is conservative. Descriptions are given to show how the non-dimensional data may be converted to force-time history. The results given are to be used for structural loads determination only.
Author (TAB)

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N68-33616 Michigan Univ., Ann Arbor.
AN EXPERIMENTAL STUDY OF SWITCHING IN A BISTABLE FLUID AMPLIFIER
Sudhir Dattatraya Savkar (Ph.D. Thesis) 1967 141 p
Available from Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-15688

A fluid amplifier apparatus with a test section 15 inches by 26 inches was fabricated from transparent plastic. Equipment to conduct visual and photographic dye and tracer studies was also incorporated. For an amplifier with a given geometry, the flow rates to the control and main jet nozzles were measured together with the switching time. The effect of varying the splitter location, offset, setback and control to main jet nozzle width ratio on switching time was measured by comparing the switching times for different values of the parameter being tested. From the results of the photographic dye and tracer studies it was observed that the switching process is not one of separation, but rather the growth and shedding of the vortex in the separation bubble. The role of the control jet is to augment the vortex in the separation bubble until the vortex reaches a threshold strength from which its growth is self-sustaining.
Dissert. Abstr.

N68-34234*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
EFFECT OF AMOUNT OF ELECTROLYTE, DRAIN RATE AND ELECTRODE GEOMETRY ON PERFORMANCE OF COPPER OXIDE–MAGNESIUM THERMAL CELLS
Lawrence H. Thaller Washington Sep. 1968 15 p refs
(NASA-TN-D-4790) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Studies continued on the performance of Mg/LiCl–KCl/Cu_2O–CuO thermal cells operating at 450°C. The measure of performance used is the parameter X, the depth of discharge at which the approximate 0.25-V drop in open circuit voltage occurs. This parameter was evaluated as a function of three factors which influence mass transport, namely, the amount of electrolyte, the rate of discharge, and the electrode shape and spacing. The amount of electrolyte per unit of cell capacity had little effect on X. In tests on horizontal- and vertical-type cells, X was inversely related to current density, with a stronger dependence on current density for cells with poorer mass transport characteristics. An increase in current density and decrease in operating temperature promoted premature failure (low cathode utilization).
Author

N68-34283*# Texas Instruments, Inc., Dallas.
LITHIUM-DIFFUSED SOLAR CELLS Quarterly Report, 1 Apr.–30 Jun. 1968
Don L. Kendall and James K. Fisher Jul. 1968 13 p refs
Prepared for JPL
(Contracts NAS7-100; JPL-952248)
(NASA-CR-96807; Rept.-03-68-57; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Recovery data of previously produced lithium-diffused solar cells were analyzed after irradiation with high-energy electrons. These analyses resulted in a change in the type of cell blank used for lithium diffusion. Solar cells were made of two of the three major types of silicon, namely, quartz-crucible, and Lopex. Electrical characteristics of these cells are presented. Future cells will be fabricated using float-zoned silicon, as well as varied base and doping processes. Also, several samples of lithium-diffused silicon of various resistivities were prepared in a Hall bar configuration and tested.
Author

N68-34301# Varta Aktiengesellschaft Forschungs- und Entwicklungszentrum, Kelkheim (West Germany).
STUDY OF THE DEVELOPMENT OF BATTERY ELECTRODES FOR SPACE APPLICATIONS [STUDIE ZUR ENTWICKLUNG VON AKKUMULATORELEKTRODEN FUR WELTRA UMZWECKE]
W. Löser Jun 1968 56 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMwF-FBW-68-39) CFSTI: HC $3.00/MF $0.65

Thin porous nickel sinter plates with homogeneous pore systems were obtained by pressing and sintering of carbonyl nickel powders. The influence of the conditions of preparation on the properties of the sinter plates and the relations between different properties were investigated and can be described by empirical equations. This offers the possibility to prepare electrodes with defined properties, necessary to meet the requirements of the cells. Various methods for the impregnation of the plates were studied. Preferably processes with few operations were chosen, since they are more likely to result in electrodes with higher homogeneity and better reproducibility.
Author (ESRO)

N68-34330*# Martin Co., Denver, Colo.
INVESTIGATION OF THE FEASIBILITY OF STERILE ASSEMBLY OF SILVER–ZINC BATTERIES
Arnold A. Rothstein, Evan R. Jones, and Roger D. Knight [1968] 114 p refs
(Contract NAS1-7656)
(NASA-CR-66671) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The study encompassed: (1) sterilization compatibility of the cell components and materials under flight acceptance dry heat sterilization (125°C for 60 hr) and autoclave conditions; (2) assembly of 12 "standard" cells under normal manufacturing conditions, 12 "control" cells from sterilized components using normal manufacturing conditions, and 24 "sterile" cells from sterilized components under sterile isolator conditions; (3) electrical performance tests of each type assembly with comparison of charge/discharge data to determine degradation effects; (4) associated biological controls and assays during sterile assembly and post-electrical testing operations; and (5) development of a variety of packaging concepts to maintain sterility in the factory-through-launch sequence.
Author

N68-34342# Illinois Univ., Urbana. Group Effectiveness Research Lab.
THE EFFECTS OF TASK ORGANIZATION AND MEMBER COMPATIBILITY ON LEADER-MEMBER RELATIONS IN SMALL GROUPS

Daniel R. Ilgen and Gordon O'Brien Jul. 1968 37 p refs
(Contract Nonr-1834(36); ARPA Order 454)
(TR-58; AD-672343)

Task cooperation requirements and group member compatibility effects on leader-member relations in three person laboratory groups were studied. Using Structural Role Theory, two forms of cooperation were defined-coordination and collaboration. Member compatibility was defined by Schutzs (1958) interchange compatibility on three needs measured by his FIRO-B scale. The needs were (1) need for affection, (2) need for inclusion, and (3) need for control. The results showed that leader-member relations were affected by (1) the coordination requirements of the task and by (2) the interaction of the collaboration requirements with the compatibility of group members. The implications of the results for Fiedlers (1964, 1967) Contingency Model of leadership were discussed.
Author (TAB)

N68-34406# Los Alamos Scientific Lab., N. Mex.
LAMPF 200 MHz POWER SOURCES
J. R. Faulkner and T. J. Boyd, Jr. [1968] 5 p Presented at Conf. on Proton Linear Accelerators, Upton, N. Y.
(Contract W-7405-ENG-36)
(LA-DC-9452; Conf-680515-8) CFSTI: HC $3.00/MF $0.65

From Conference on Proton Linear Accelerators, Upton, N. Y. The Alvarez section of the proton linear accelerator for the Los Alamos Meson Physics Facility will require three 3 MW and one 300 kW, 200-MHz rf power sources. The power delivered to the accelerator tanks must be controlled over a dynamic range of approximately 30% while maintaining a field amplitude tolerance of $\approx \pm 1.5\%$ with a phase tolerance of $\approx \pm 2°$. The minimum rf duty factor (DF) requirement is 8.4% (for a 6% DF beam) with a design capability of 14.4% (12% beam). The moderate peak but high average power requirements have had a considerable impact on the design and engineering of the rf amplifier cavities and their peripheral circuitry. A description of the system is presented, and problems encountered in the design are discussed.
NSA

N68-34441# European Atomic Energy Community, Ispra (Italy). Physical Chemistry.
EVALUATION OF MAGNETOCALORIC CONVERTERS
J. Donea, F. Lanza, and E. Van der Voort Brussels 1968 60 p refs
(EUR-4039.e)

Mechanical power can be produced by cycling thermally a ferromagnetic suspension (ferrofluid) in the presence of a magnetic field through a range of temperatures such that its magnetization changes appreciably. Appropriate ferrofluids and cycles to make this form of power practical are reviewed and evaluation is made of their practical efficiencies and specific power. Choice is made of a practical cycle for which a preliminary dimensioning and a draft design are presented.
Author

N68-34463# Gulton Industries, Inc., Metuchen, N. J. Research and Development Div.
DESIGN, FABRICATION OF PROTOTYPES, AND TESTING OF SEALED RECHARGEABLE SILVER-CADMIUM CELLS Interim Quarterly Report Number 2, Jun. 1968-Mar. 1968
S. Charlip Mar. 1968 24 p refs
(Contract DA-36-039-AMC-03358(E))
(ECOM-03358-2; AD-672502)

The manufacture of the pasted silver electrodes and of the pressed cadmium electrodes, for this program is described. Both electrodes have pure silver substrates of one-piece construction. The separator system used in the sealed cells is delineated. Cell construction and assembly is given in detail, with accompanying drawings. The activation and formation procedures for AG-15S cells are described. Data from AG-15S test cells are presented in tabular and graphic form. The results of the tests and conclusions to be drawn from them are discussed.
Author (TAB)

N68-34592# Geoscience, Ltd., Solana Beach, Calif.
INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS BIANNUAL REPORT, 1 OCT. 1967-31 MAR. 1968
H. F. Poppendiek, N. D. Greene, W. B. Goddard, and C. M. Sabin 31 Mar. 1968 31 p refs
(Contract AT(04-3)-677)
(SAN-677-25; GLR-62) CFSTI: HC $3.00/MF $0.65

Research activities on phase distributions in forced flow boiling applicable to Rankine cycle systems is reported. A microscopic photographic system has been designed and constructed for use in boiling mercury phase distribution research. Magnifications from 2.5 to 20X are available with both high speed Polaroid and 35 mm exposures; higher amplifications are achievable through a projection magnifier. Timing circuits have been developed which also allow mercury droplet velocities to be deduced. Photographs of two phase, gas-mercury flow have been obtained with the microscopic photographic system. Phase distributions of mercury from zero to 50% equivalent vapor qualities have been photographed within a transparent 3/8 inch boiler tube in a low temperature, recirculating system. The satisfactory operation of the phase distribution system, conductance measurements, and photographs of phase distributions have been made for helical, forced flow mercury boiling.
Author (NSA)

N68-34752*# Naval Ammunition Depot, Crane, Ind. Quality Evaluation Depot.
EVALUATION PROGRAM FOR SECONDARY SPACECRAFT CELLS. CYCLE LIFE TEST Annual Report
E. C. Bruess 14 May 1968 324 p
(NASA Order W-11252-B)
(NASA-CR-96645; QE/C-68-138; AR-4) CFSTI: HC $3.00/MF $0.65 CSCL 10C

A total of 12 combinations of test parameters was included in the program undertaken to study the effects of the cycle period, environmental temperature, percent of recharge, and depth of discharge on the cycle life of sample classifications of cells. The load conditions include cycle lengths (orbit periods) of 1.5, 3.0, 8.0, and 24 hours, and depths of discharge ranging from 10% to 75%. Environmental conditions include ambient temperatures of -20°, 0° 25°, 40°, and 50°C with normal atmospheric conditions, and a cycling temperature of 0° to 40°C within a 24-hour period. The packs are cycled until more than half of the cells in each pack have failed. Charge control methods used are voltage limit, auxiliary electrode, coulometer, stabistor, and a two-step regulator. Also tested were specially constructed cells to apply internal pressure against the face of the plate stack, and a type to permit high charge rates. Extensive data tabulations are given on all active and completed packs.
M.G.J.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N68-33698 Northwestern Univ., Evanston, Ill.
THE EFFECT OF FLUID IN THE MIDDLE EAR CAVITY ON BONE-ELICITED COCHLEAR MICROPHONIC POTENTIALS OF THE CAT'S EAR

Craig Oliver Linnell (Ph.D. Thesis) 1967 166 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-15278

In this study, measurements were made of cochlear microphonic (CM) magnitude and phase changes after filling the auditory bulla of the cat with mineral oil. Data were reported on twelve animals. The CM was recorded with an electrode placed in the scala tympani of the basal turn of the cochlea. Measurements were obtained by both bone and air-conducted sound stimuli over a frequency range of .2–10 kHz for pseudo-threshold changes and .2–3 kHz for phase changes. Long-term steady-state measurements were possible by blocking the Eustachian tube and sealing the auditory bulla so that the fluid remained in the cavity. Absolute (pressure and force) measures were obtained at the 3 microvolt (RMS) CM level from 200 Hz to 10 kHz with both intact and fluid-filled middle ear. The differences between these two measures were attributed to the effect of the fluid in the middle ear. Dissert. Abstr.

N68-33715*# National Academy of Sciences—National Research Council, Washington, D. C.
PHYSIOLOGY IN THE SPACE ENVIRONMENT. VOLUME 2: RESPIRATION
1967 170 p refs Conf. held Woods Hole, Mass., Jun.– Jul. 1966
(Contract NSR-09-012-036)
(NASA-CR-96635; Publ.-1485-B, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 06S

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16. RESPIRATORY DRUGS AND MANNED SPACE FLIGHT P. E. Morrow p 143–148 refs (See N68-33731 21-04)

N68-33716*# National Academy of Sciences-National Research Council, Washington, D. C.
STRUCTURAL CHANGES IN LUNG AND THORAX
Norman C. Staub *In its* Physiol. in the Space Environment. Vol. 2 1967 p 21–25 refs (See N68-33715 21-04)

While there is no apparent reason to expect prolonged space flight to cause changes in primary lung structure, general deconditioning of the body could extend to the thoracic cage and muscles, altering the mechanics of ventilation. Such factors as radiation, inhalation of particulates and contaminants, and possible tissue damage resulting from higher than normal P_{O_2} could lead to cellular changes in the lungs. Author

N68-33717*# National Academy of Sciences-National Research Council, Washington, D. C.
RESPIRATORY MECHANICS
Jere Mead *In its* Physiol. in the Space Environment. Vol. 2 1967 p 26–30 refs (See N68-33715 21-04)

Sufficient acceleration will limit or prevent lung movements during launch, but such periods will probably not exceed the limits of breath holding. The mechanical strength of the lung may place a limit on the accelerative forces to which the human body can safely be subjected. Probably the pulmonary blood vessels would rupture before the parenchyma tore. During zero G, changes in lung mechanics would be minimal. One would predict a decrease of about 20 percent in end-expiratory lung volume and a resulting small decrease in airway conductance. Inspiration of particulate matter might be more common, in which case the cough mechanism is more important. On theoretical grounds, the air velocity with a cough would probably be greater, but the decreased density of the gas might make the cough less effective. Author

N68-33718*# National Academy of Sciences-National Research Council, Washington, D. C.
PULMONARY GASEOUS DIFFUSION
Norman C. Staub *In its* Physiol. in the Space Environment. Vol. 2 1967 p 31–37 refs (See N68-33715 21-04)

There is no reason to suppose that gaseous-diffusion processes will be affected by zero G, unless the lung parenchyma sustains chronic or acute damage secondary to accelerations at launch or re-entry. Author

N68-33719*# National Academy of Sciences—National Research Council, Washington, D. C.
PULMONARY CIRCULATION AND THE DISTRIBUTION OF BLOOD AND GAS IN THE LUNGS
Solbert Permutt *In its* Physiol. in the Space Environment. Vol. 2 1967 p 38–56 refs (See N68-33715 21-04)

Prolonged space travel appears to offer no significant problems in this respect. On the contrary, the relations between blood flow and ventilation are likely to be optimal in the weightless state. Acceleration may produce adverse effects, however, and it is important to be able to evaluate risks and the physiological tolerance involved. Basic knowledge is needed concerning the effect of acceleration on the blood volume and capacitance of the systemic circulation, and of changes of volume in the vascular structures of the thorax presumably caused by reflex and hormonal mechanisms. The effects of gravity are so profound in altering the distribution of blood and gas within the lungs that many problems in basic pulmonary physiology can be studied more effectively under weightlessness than in a normal gravitational field. One of the dividends of space flight will be the opportunity to carry out experiments on the lungs that are impossible on earth. Author

N68-33720*# National Academy of Sciences-National Research Council, Washington, D. C.
REGULATION OF BREATHING
Jere Mead *In its* Physiol. in the Space Environment. Vol. 2 1967 p 57-58 ref (See N68-33715 21-04)

The slight alterations in pulmonary mechanics to be expected under zero G and possible deviations in inspired oxygen and carbon dioxide, depending on the composition of the cabin atmosphere, could affect the level of ventilation through well-known mechanisms. Current knowledge indicates that these effects would be too small to be physiologically significant. Minute volume tends to decrease during acceleration even to the point of apnea, but as long as its duration is brief no more serious stress than that of ordinary breath holding would exist. Hyperventilation can occur under stress, but it is not a problem unique to space flight. Author

N68-33721*# National Academy of Sciences—National Research Council, Washington, D. C.
EXCHANGE OF FLUIDS IN LUNGS
Arthur B. DuBois *In its* Physiol. in the Space Environment. Vol. 2 1967 p 59-65 refs (See N68-33715 21-04)

Fluid may enter the lungs through aspiration of secretions or by transudation from the lung capillaries. Such fluids would normally be removed by the various lung-clearing mechanisms, which should operate sufficiently well in space flight. Intentional filling of the lungs or pleural space with liquid to support the pulmonary blood vessels and lung parenchymal tissues during accelerations greater than 15 G may be tried experimentally in anticipation of life-support systems for flights far in the future and for the re-entry phase of the flight. Author

N68-33722*# National Academy of Sciences—National Research Council, Washington, D. C.
RESPIRATORY TRACT CLEARANCE MECHANISMS FOR NONGASEOUS MATERIALS
Paul E. Morrow *In its* Physiol. in the Space Environment. Vol. 2 1967 p 66-78 refs (See N68-33715 21-04)

Three physiological mechanisms keep epithelial surfaces of the respiratory tract relatively free of contaminants: (1) ciliary mucous transport, (2) endocytosis, and (3) lymphatic drainage. Ciliary mucous transport may be affected, probably slightly, by gravity and may also be influenced by the high concentration of ions presumed to exist in space capsules. In vitro and in vivo preparations exist for study of mucous transport and should be employed to test responses under appropriate conditions. There is no evidence that endocytosis is influenced by gravity, but on the other hand there is insufficient data on endocytosis in mammals. Little is known about the role and mechanism of pulmonary lymphatic drainage even under normal gravity conditions. Author

N68-33723*# National Academy of Sciences—National Research Council, Washington, D. C.
DIFFUSION OF GASES IN PERIPHERAL TISSUE
Kenneth L. Zierler *In its* Physiol. in the Space Environment. Vol. 2 1967 p 79-86 refs (See N68-33715 21-04)

If translocation of O_2 within tissues is, as most of the evidence suggests, caused purely by diffusion driven by gradients in P_{O_2}, the gravitational field or lack of it should not have any important effect on the diffusion itself. To insure adequate delivery of O_2 to the tissues, arterial capillary P_{O_2} should be maintained at the normal value at sea level. Given this condition, adequate oxygenation of tissues will depend on functional capillary blood flow, which determines the volume of tissue supplied by each capillary. The distribution of functional capillary blood flow conceivably can be affected by variations in and lack of gravity. Author

N68-33724*# National Academy of Sciences—National Research Council, Washington, D. C.
TEMPERATURE REGULATION
David Minard *In its* Physiol. in the Space Environment. Vol. 2 1967 p 99-101 refs (See N68-33715 21-04)

It is not anticipated that the role of the respiratory system as a heat exchanger will be significantly altered during space travel. If the space cabin atmosphere has a lower total pressure or uses helium as an inert gas, the decreased air density will cause a slight and physiologically insignificant decrease in body heat lost to the inspired air. Except for the possibility of heat hyperpnea under unusual or emergency situations, heat loads encountered in space travel should have minor influence on the level of minute ventilation. The possibility of untoward temperature regulation resulting from altered circulation in the weightless state is conceivable but on the basis of present knowledge is unlikely. Author

N68-33725*# National Academy of Sciences—National Research Council, Washington, D. C.
OXYGEN TOXICITY AT NEAR-NORMAL PARTIAL PRESSURES
Robert E. Davies *In its* Physiol. in the Space Environment. Vol. 2 1967 p 93-98 refs (See N68-33715 21-04)

The basic metabolic defect (or defects) associated with the physiological changes caused by O_2 toxicity are still unknown. The literature fails to demonstrate that increased inspired P_{O_2} (at least to 5 psi) is safe for prolonged use by man. Further testing for long periods with human subjects is essential before such a conclusion can be drawn. Normal (sea level) partial pressures of inspired O_2 are known to be acceptable. Reduced partial pressures may also be acceptable, and sometimes unavoidable, but the conditions and limits have yet to be pinpointed. Author

N68-33726*# National Academy of Sciences—National Research Council, Washington, D. C.
CONSIDERATIONS OF CARBON DIOXIDE CONCENTRATION
Robert E. Forster *In its* Physiol. in the Space Environmnet. Vol. 2 1967 p 99-101 refs (See N68-33715 21-04)

Ideally, from the physiological point of view, it would be best to keep inspired P_{CO_2} close to zero, as it is under normal sea-level conditions. In the manned space flights to date the circulating atmospheric P_{CO_2} has apparently been kept to less than 7.6 torr, although this may be because of engineering (thermal exchange) rather than physiological considerations. A maximum limit of 7.8 torr was chosen because chronic exposure to CO_2 concentrates just above that limit has demonstrated adaptive changes. The effect of chronic exposure to low inspired concentrations of CO_2 should be explored. Furthermore, a time-concentration-response curve exposure should be obtained to guide procedure in the event that the CO_2-removing equipment fails. Author

N68-33727*# National Academy of Sciences—National Research Council, Washington, D. C.
INERT GASES
Wallace O. Fenn *In its* Physiol. in the Space Environment. Vol. 2 1967 p 102-112 refs (See N68-33715 21-04)

Advantages of adding an inert gas or gases to the space cabin atmosphere are that (1) fire danger is reduced; (2) aural and pulmonary atelectasis is inhibited; (3) there is a possible, but unproved, long-term physiological need for at least low pressures of nitrogen; and (4) ventilation and heat dissipation within the cabin may require a total gas pressure greater than the ceiling recommended for cabin P_{O_2}. The only physiological disadvantage is the risk of the gas's producing the bends. There may be engineering

disadvantages in that a double monitoring system is required and, depending on cabin leakage, there will be the extra cost of carrying a supply of inert gas. With a possible exception if absolute lack of nitrogen for long periods proves deleterious, a deficit not overcome by helium, there is little to choose between nitrogen and helium. It was concluded that some inert gas should be added, at least until an effective method of controlling fires in 100 percent oxygen becomes available. Author

N68-33728*# National Academy of Sciences—National Research Council, Washington, D. C.
TRACE CONTAMINANTS
Joseph C. Ross *In its* Physiol. in the Space Environment. Vol. 2 1967 p 113–122 refs (See N68-33715 21-04)

Because the capsule gas is recycled, contaminants that are normally present in only neglibible amounts may increase to toxic levels and may concentrate on airborne particulate matter, which in turn will be increased in the absence of the sedimentation process. All the existing and possible atmospheric contaminants in the space capsule, including gases, particles, and infectious agents, have not been identified, nor have their effective concentrations been determined. These contaminants should be monitored and regulated, pre-flight and in-flight (manned), with particular attention to contaminants produced by fire or unusual heat in the vehicle. The threshold limit value (TLV) of tolerance to various contaminants should be determined for continuous exposure, as contrasted with the more usual intermittent exposure, and the possibly additive effect of stress and infection should be included. Author

N68-33729*# National Academy of Sciences—National Research Council, Washington, D. C.
PARTICULATE MATTER: GENERAL CONSIDERATIONS AND AEROSOL DEPOSITION IN MAN
Paul E. Morrow *In its* Physiol. in the Space Environment. Vol. 2, 1967 p 123–130 refs (See N68-33715 21-04)

In zero G at hypobaric pressure, airborne stability of dusts will be affected by inertial impaction (large particles), by diffusion or deposition by Brownian motion (smallest particles), but not by sedimentation. Interception of fibers (small diameter, great length) may increase in the bronchial tree. A different distribution of aerosol deposition in the respiratory tract is thus anticipated with respect both to particle size and to site. This has important implications for production of pulmonary disability. It is recommended that studies of aerosol composition (size and association of contaminants with various particle sizes) be instituted. Moreover, tests should be made in simulated respiratory tracts to determine the size and site of deposition of aerosols under flight conditions. Additional studies of aerosol-removal methods are also indicated. Author

N68-33730*# National Academy of Sciences—National Research Council, Washington, D. C.
INFECTION
Joseph C. Ross *In its* Physiol. in the Space Environment. Vol. 2 1967 p 133–141 refs (See N68-33715 21-04)

The likelihood of microbial infections increases with (1) the size of the space crew; (2) less than ideal facilities for personal hygiene over long periods; (3) possibly altered viability of microorganisms, autoflora, and mechanisms of challenge; and (4) individual susceptibility associated with the space cabin environment. It is recommended that microbial content of the space vehicle be controlled, that consideration be given to selection of space crews on the basis of similar immunological patterns (including cross matching for blood types), and that crews be isolated as a group before the flight both to prevent exposure to infection and to allow cross-immunity to develop. Author

N68-33731*# National Academy of Sciences—National Research Council, Washington, D. C.
RESPIRATORY DRUGS AND MANNED SPACE FLIGHT
Paul E. Morrow *In its* Physiol. in the Space Environment. Vol. 2 1967 p 143–148 refs (See N68-33715 21-04)

Space flight conditions may lead to nasal congestion, obstructed sinuses, and the like, and to the increased possibility of inhaling food and large particles. Decongestants and dilators would probably be needed in such instances. Pulmonary infection would require a battery of therapeutic agents similar to those used at sea level. Otherwise, there appear to be no specific considerations peculiar to space flight. A critical review of possible problems and of the methods by which drugs have been selected, tested, and dispensed, indicates that the subject needs thorough study and, possibly, continuing evaluation by an advisory board. Author

N68-33766*# Florida Univ., Gainsville.
SOME PROPERTIES OF THE HYDROGEN BONDS IN BIOCHEMISTRY WITH PARTICULAR REFERENCE TO THE STABILITY OF THE GENETIC CODE
Per-Olov Loewdin 31 Aug. 1966 61 p refs Submitted for publication *Its* Preprint No. 98
(Grant NsG-512)
(NASA-CR-83448) CFSTI: HC $3.00/MF $0.65 CSCL 06A

An overview and analysis of the biological developments concerned with the DNA molecule are presented, with sections on the structure and stability of DNA; character of the genetic code; stability of the genetic code at replication; and internal stability of the genetic code in DNA. The stability of the genetic code, as expressed in the template idea is investigated with particular emphasis on proton changes (tunneling and jumping) between hydrogen bond electron pairs. A clarification of why spontaneous mutations are as rare as they are, and specific models for radiation or chemically induced mutations are presented. Preliminary theoretical results confirm the template idea, the importance of the H bonds in storing and transferring genetic information, and the fact that the genetic code in the Watson–Crick model has long time stability. B.P.

N68-33908 Minnesota Univ., Minneapolis.
A STUDY OF THE EFFECT OF PROFOUND LOCAL GASTRIC HYPOTHERMIA—GASTRIC FREEZING—ON THE TURNOVER OF CELLS IN THE NORMAL RAT GASTRIC MUCOSA EMPLOYING THE UPTAKE AND INCORPORATION OF TRITIUM (H-3) LABELLED THYMIDINE AS AN INDICATOR
Arthur Storer McFee (Ph.D. Thesis) 1967 133 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-14631

A two-fold study has been carried out in rats to determine (1) the effect of gastric freezing on the development of peptic ulcers in response to stress and then to determine (2) the effect of freezing on the natural reproduction and turnover of gastric mucosal cells. In rats studied up to six weeks after freezing and paired with nonfrozen controls a significant protective effect of prior gastric freezing was shown when the rats were challenged with an ulcerogenic stimulus (starvation and cold). This effect was noted at six weeks, however, it was less than at one to two weeks after freezing. In three groups of rats studied (one hour, one week, and six weeks after freezing) by microradioautographs of the gastric mucosa after H^3 thymidine injection, no changes from a control pattern could be seen in the cellular uptake of thymidine or in the normal mucosal cell turnover. Dissert. Abstr.

N68-33909# Joint Publications Research Service, Washington, D. C.
SPACE BIOLOGY AND MEDICINE
19 Sep. 1968 174 p refs Transl. of Kosmich. Biol. i Med. (Moscow), v. 2, no. 3, 1968
(JPRS-46456) CFSTI: HC $3.00/MF $0.65

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10. EFFECT OF HYPOKINESIA ON HUMAN CIRCULATION V. S. Georgiyevskiy and V. M. Mikhaylov p 73–78 refs (See N68-33919 21-04)

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17. EVAPORATION UNDER LOW ATMOSPHERIC PRESSURE CONDITIONS I. N. Chernyakov, I. V. Maksimov, and P. Ya. Azhevskiy p 129–136 refs (See N68-33926 21-04)

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N68-33910# Joint Publications Research Service, Washington, D. C.

PSYCHOMOTOR REACTIONS IN MONKEYS DURING FLIGHTS IN A BALLISTIC CURVE

R. Grandpierre *In its* Space Biol. and Med. 19 Sep. 1968 p 1–7 (See N68-33909 21-04)

Trained monkeys were exposed to weightless flight conditions and their sensory and motor spontaneous electrical potentials were registered and evaluated. Results show that several tenths of g were adequate to sustain some physiological functions; however, weightlessness caused a reduction in psychic tone as indicated by the appearance of large spindles in the monkey EEG's. All EEG's returned to normal immediately after descent to the field laboratory.

G.G.

N68-33911# Joint Publications Research Service, Washington, D. C.

EFFECT OF AMOBARBITAL SODIUM AND SOMATOTROPHIC SYNDROME ON MICE DURING PROLONGED HYPOKINESIA

L. A. Kravchuk and V. G. Ovechkin *In its* Space Biol. and Med. 19 Sep. 1968 p 8–15 refs (See N68-33911 21-04)

A 35-day experiment conducted on mice exposed to hypokinesia and isolation showed that test animals differed from controls in their weight changes, mortality rate, orthostatic tolerance and sensitivity to isobarbital sodium (as judged by the mean effective dose, time of onset and duration of sleep). The preliminary administration of somatotropic hormone resulted in the prolongation of sleep induced by amobarbial soldium by three or four times, the ED_{50} of the latter remaining unchanged.

Author

N68-33912# Joint Publications Research Service, Washington, D. C.

EFFECT OF HYPEROXIA ON THE HEART AND LUNGS OF WHITE RATS

A. R. Mansurov, F. V. Babchinskiy, I. G. Krasnykh, and L. A. Tyutin *In its* Space Biol. and Med. 19 Sep. 1968 p 16–21 refs (See N68-33909 21-04)

The objective of this study was an investigation of pathological changes developing in the thoracic organs of white rats as a result of their exposure to hyperoxia of different levels and durations. The changes involved focal and infiltration lesions in the lungs, exudation in the pleural cavity, segmental and lobar atelectasis, disturbed mobility of the diaphragm and increased size of the heart. An exposure of the animals to pure oxygen for 48 hours repeated four times with an interval of five days led to the development of pulmonary emphysema and functional changes of the myocardium. An exposure of animals to nitrogen (30%)-oxygen (70%) atmosphere at an altitude of 2,400 m produced pathological changes in the heart and lungs. However, they were manifested after a longer period of time than in the case of a 100%-oxygen atmosphere. A 20-day exposure to a 50% oxygen atmosphere did not result in any functional or morphological changes in the thoracic organs.

Author

N68-33913# Joint Publications Research Service, Washington, D. C.

STABILIZATION OF THE CONCENTRATION OF MINERAL NUTRITION ELEMENTS IN A MEDIUM DURING PROLONGED CHLORELLA CULTIVATION WITH RECOVERY OF THE MEDIUM

Ye. K. Lebedeva, G. I. Meleshko, T. B. Galkina, and N. N. Yegorova *In its* Space Biol. and Med. 19 Sep. 1968 p 22–31 refs (See 68-33909 21-04)

It has been shown that the mineral nutrition of Chlorella during its prolonged intensive cultivation with recovery of the medium can be stabilized. The concentration of certain elements (N, P, S, Mg, K, Fe and trace elements) was maintained at a specified level by the addition of a single correcting solution whose

composition fully satisfied the needs of the cells for these elements. The solution was added to the medium in small portions in accordance with the increase in biomass. Fluctuations in the concentration of the observed elements occurred due to changes in the structure of the algal population which caused alterations in cell metabolism. Author

N68-33914# Joint Publications Research Service, Washington, D. C.

STUDY OF THE OXIDATIVE-CATALYTIC METHOD FOR MINERALIZATION OF WASTES IN A CLOSED ECOLOGICAL SYSTEM

S. V. Chizhov, Yu. Ye. Sinyak, V. V. Kranoshchekov, B. G. Gusarov, S. O. Kuznetsov et al *In its* Space Biol. and Med. 19 Sep. 1968 p 32–39 (See N68-33909 21-04)

Preliminary studies of the oxidative-catalytic method for the mineralization of wastes have been made. This method is based on the pyrolytic decomposition of wastes and exposure of the pyrolysis products to oxidation in the presence of a catalyst. The optimal parameters of the process have been experimentally established: temperature in the decomposition ones—450°C and in the zone of oxide catalysts—250–300°C at normal atmospheric pressure. The nutrient solutions utilizing ash obtained from the wastes have been evaluated from the biological point of view. Mineralized products have been shown to be useful in the cultivation of lower plants (Chlorella). Author

N68-33915# Joint Publications Research Service, Washington, D. C.

MATHEMATICAL MODEL OF A LIFE SUPPORT SYSTEM

V. A. Darg and B. G. Kovrov *In its* Space Biol. and Med. 19 Sep. 1968 p 40–47 refs (See N68-33905 21-04)

This paper gives a mathematical description of a partially closed biological system. The distinguishing characteristic of the system is that it regenerates some expendables, others being stored. When optimizing the main function of the system related to its mass it is necessary to solve the following equation: $\min/x \geq 0|A(x)\,t + G(x,t)|$, where T is the lifetime of the system. It is indicated that further analysis of the suggested model is promising for the study of life support systems. Author

N68-33916# Joint Publications Research Service, Washington, D. C.

DYNAMICS OF ORTHOSTATIC TOLERANCE OF ATHLETES AFTER FORTY-DAY HYPOKINESIA

A. V. Korobkov, L. A. Ioffe, M. A. Abrikosova, and Yu. M. Stoyda *In its* Space Biol. and Med. 19 Sep. 1968 p 48–57 refs (See N68-33909 21-04)

The effect of forty-day hypokinesia on the changes of the electrocardiogram, cardiodynamics and tone of vessels of the elastic and muscular type was studied in ten highly trained athletes during their orthostatic tests. The orthostatic response exhibited an increased predominance of sympathetic effects in the heart and a reduced blood filling of the ventricles due to a deterioration of the functional state of the venous system. It was found that the stability of the latter can be maintained by means of specific training. Author

N68-33917# Joint Publications Research Service, Washington, D. C.

DYNAMICS OF DAILY DIURESIS, CREATININE EXCREATION AND MEAN THICKNESS OF THE FATTY SKIN LAYER IN ATHLETES SUBJECTED TO PROLONGED HYPOKINESIA

A. A. Korobova and Yu. B. Vinichenko *In its* Space Biol. and Med. 19 Sep. 1968 p 58–63 refs (See N68-33909 21-04)

This study was made to determine the dyanmics of daily diuresis, creatinine excretion and mean thickness of the fatty skin layer in male athletes (runners and weightlifters) during forty-day hypokinesia. Daily diuresis was determined with an accuracy to 1 ml, creatinine was assessed by the photoelectrocolorimetric technique and the mean thickness of the fatty skin layer was measured with standard calipers. The difference between the mean values of creatinine excretion on different days of the experiment was not statistically significant. The diuresis level decreased in most test cases during the second part of the experiment. The mean thickness of the fatty skin layer increased. Insignificant fluctuations in creatinine excretion and increase in the mean thickness of the fatty skin layer indicate a reduction in protein synthesis, an increase in decomposition processes and replacement of a part of the muscle tissue by fat. The decrease in daily diuresis by the end of the experiment occurs due to a changed level of fat metabolism and the Gauer–Henry reflex. Author

N68-33918# Joint Publications Research Service, Washington, D. C.

EFFECT OF PROLONGED BEDREST ON MUSCLE TONE AND PROPRIOCEPTIVE REFLEXES IN MAN

M. A. Cherepakhin *In its* Space Biol. and Med. 19 Sep. 1968 p 64–72 refs (See N68-33909 21-04)

A 62-day experiment was carried out to study the effect of prolonged bedrest and physical exercises on the muscle tone and proprioceptive reflexes in man. One group of test subjects performed physical exercises in a prone position. The exercises were performed for 2 1/2 hours daily with an intensity 600–1,200 kgm/min. The prolonged bedrest experiment reduced the muscle tone in the test subjects, particularly in those who performed no physical exercises. The decrease in muscle tone produced no effect on the proprioceptive reflexes, their latent periods being dependent on the length of the reflex path. Author

N68-33919# Joint Publications Research Service, Washington, D. C.

EFFECT OF HYPOKINESIA ON HUMAN CIRCULATION

V. S. Georgiyevskiy and V. M. Mikhaylov *In its* Space Biol. and Med. 19 Sep. 1968 p 73–78 refs (See N68-33909 21-04)

The combined effect of bedrest and accelerations on human circulation was studied using mechano- and polycardiographic techniques. The experiments were conducted on young healthy male test subjects. The experiments demonstrated an increase in heart rate and average blood pressure, a decrease in the ejection period and development of orthostatic hypotension. Variations in some hemodynamic indices indicated a phasic pattern reaching a maximum on the 32d–42d day. Author

N68-33920# Joint Publications Research Service, Washington, D. C.

NEUROLOGICAL CHANGES IN HEALTHY SUBJECTS INDUCED BY TWO-MONTH HYPOKINESIA

Yu. N. Purakhin and B. N. Petukhov *In its* Space Biol. and Med. 19 Sep. 1968 p 79–85 refs (See N68-33909 21-04)

Six healthy male test subjects were twice exposed to accelerations followed by a 62-day bedrest during which three test subjects performed physical exercises of a known intensity. The study included tests of the nervous system, electroencephalographic recordings, physiological tremor and fluctuations of the body center of gravity (stabilography). During the first two weeks of the experiment the test subjects exhibited symptoms of asthenic reactions in their behavior and nervous system. Later the symptoms become more serious, acquiring the form of neurological symptoms and an asthenic syndrome (neurasthenia). An analysis of data on the tremor, electroencephalogram and stabilography also indicated the development of changes in the central nervous system, autonomic

nervous system and orthostatic tolerance in response to long-term hypokinesia. Functional shifts were accompanied by morphological changes in the muscular system. Author

N68-33921# Joint Publications Research Service, Washington, D. C.
ARTERIAL TONE IN RELATION TO RESTRICTED MUSCULAR ACTIVITY
N. Ye. Panferova and V. A. Tishler *In its* Space Biol. and Med. 19 Sep. 1968 p 86–95 refs (See N68-33909 21-04)

Experimental data are presented concerning the dynamics of some indices characterizing arterial tone prior to, during and following 5- to 20-day exposure of sixteen test subjects to hypodynamia or relative physiological rest (in a chair or bed). Recordings were made of the velocity of the pulse wave distribution in the aorta and vessels of the arm and leg; calibrated pulse amplitude of the vessels of the second and fourth fingers and toes (mm^3); skin temperature of the chest, forehead, back of the hand and foot and front part of the shin. Before and after the experiment the test subjects underwent 15- to 2-minute tilt table tests during which time the above indices were recorded. It was found that hypodynamia resulted in an increased constriction of vessels in the lower extremities, including skin arterioles, whereas the tone of the aorta and arm vessels remained virtually unchanged. The construction of the leg vessels was more pronounced during the post-experiment orthostatic tests in comparison with that observed prior to the experiment. Author

N68-33922# Joint Publications Research Service, Washington, D. C.
THE CONCEPT "PERSONALITY AND ENVIRONMENT" IN EXPERIMENTAL SPACE PSYCHONEUROLOGY
O. N. Kuznetsov *In its* Space Biol. and Med. 19 Sep. 1968 p 96–110 refs (See N68-33909 21-04)

This paper discusses the significance of adaptation of the personality to various environments. It covers the subject and technique of experimental space psychoneurology and its role in psychoneurological examinations of human behavior during a space mission. The paper includes tables indicating unusual psychic states and psychopathological syndromes exhibited by test subjects during surdochamber experiments. They are given differential diagnoses in relation to particular environmental effects. On the basis of data in the literature and the author's own findings there is discussion of peculiarities of the personality promoting or hindering adaptation to various environments. Prolonged confinement of test subjects in isolation in surdochambers is shown to be a promising method for studying individual behavioral characteristics of the personality. Author

N68-33923# Joint Publications Research Service, Washington, D. C.
MECHANISMS OF THE EFFECT OF STRONG LIGHT STIMULI ON THE OPTIC ANALYZER
V. I. Shostak *In its* Space Biol. and Med. 19 Sep. 1968 p 111–116 refs (See N68-33909 21-04)

After an experimental flash (duration 2.1 msec, luminosity $7.8 \cdot 10^7$ nit) the recovery of light sensitivity and the b-wave component of the electroretinogram were determined during the course of adaptation to the dark which followed. The two values were closely correlated, giving evidence of the leading role played by peripheral processes in the mechanisms of adaptation to the dark. On the basis of a two-page regression curve the author derived two regression equations for different phases of adaptation to the dark. The curve showing adaptation to the dark which was constructed using these equations reveals the possibility of applying equations of this kind for an objective determination of light sensitivity and the modeling of the process of adaptation to the dark. Author

N68-33924# Joint Publications Research Service, Washington, D. C.
HUMAN LIMITS OF TOLERANCE TO INFRARED RADIATION DURING LOCAL IRRADIATION
I. I. Dedenko, N. K. Gnoyevaya, and V. S. Ivanov *In its* Space Biol. and Med. 19 Sep. 1968 p 117–123 refs (See N68-33909 21-04)

An attempt has been made to establish quantitative indices of human tolerance to infrared irradiation to be correlated with radiation intensity and the irradiated body area. The pain thresholds for temperature effects have been shown to be not dependent on the absolute skin temperature but on the rate of its increase. The higher the irradiation intensity, the lower is the absolute temperature at which a feeling of intolerable pain appears. Author

N68-33925# Joint Publications Research Service, Washington, D. C.
EFFECT OF PLANT DIETS, INCLUDING THE BIOMASS OF UNICELLULAR ALGAE, ON THE BALANCE AND EXCRETION OF MINERAL ELEMENTS
Ye. I. Pokrovskaya, A. P. Tereshchenko, and V. M. Volynets *In its* Space Biol. and Med. 19 Sep. 1968 p 124–128 refs (See N68-33909 21-04)

A 30-day experiment performed on five healthy male test subjects has demonstrated that plant diets including about 120 g of dry Chlorella biomass decrease the assimilation of calcium and magnesium and produce an insignificant negative balance of these elements on the twentieth–thirtieth day. The assimilation of potassium and phosphorus undergoes no changes and their balance remains positive throughout the experiment. Author

N68-33926# Joint Publications Research Service, Washington, D. C.
EVAPORATION UNDER LOW ATMOSPHERIC PRESSURE CONDITIONS
I. N. Chernyakov, I. V. Maksimov, and P. Ya. Azhevskiy *In its* Space Biol. and Med. 19 Sep. 1968 129–136 refs (See N68-33909 21-04)

Water losses by man wearing a pressurized suit with an oxygen mask were studied. The evaporation level was determined from changes in skin temperature and heat flux measured using a special device. Experiments were made at altitudes of 20,000 m and above. It was found that vacuum evaporation occurred from parts of the body covered by the pressurized suit. The evaporation decreased skin temperature, increased heat flux and caused a feeling of cold in test subjects. Vacuum evaporation results from an atmospheric pressure decrease down to the saturated vapor elasticity value at skin temperature, body surfaces being in contact with the ambient atmosphere through linen and suit pores. Human water losses through vacuum evaporation at altitudes of 20,000 m and above, at comfortable temperatures and at rest amount to 100 g/hour, remaining below the detrimental limit. Author

N68-33927# Joint Publications Research Service, Washington, D. C.
VARIATION PULSOGRAMS AND INDICES OF THE FUNCTION OF EXTERNAL RESPIRATION DURING EXPOSURE OF MAN TO ACUTE HYPOXIA
I. R. Kalinichenko and G. A. Nikulina *In its* Space Biol. and Med. 19 Sep. 1968 p 137–142 refs (See N68-33909 21-04)

The health of a subject exposed to acute hypoxia (two-hour enclosure at an altitude of 5,000 m without an additional oxygen supply) was determined using variation pulsograms. Indices of the function of external respiration and pulmonary gas exhange provided additional information. The experiments were conducted on six healthy male test subjects before and after their 36-hour exposure to a modified work and rest schedule. The study revealed that the health of a subject exposed to acute hypoxia can be determined using variation pulsograms. Author

N68-34004*# National Aeronautics and Space Administration, Washington, D. C.
LIFE CYCLE AND RAPID CHANGING OF ZONE TIMES DURING AERIAL TRAVEL [RYTHME DE VIE ET CHANGEMENTS RAPIDES DE FUSEAUX HORAIRES AU COURS DES VOYAGES AERIENS]
J. La Vernhe Aug. 1968 12 p refs Transl. into ENGLISH from Presse Med. (Paris), v. 72, no. 44, 24 Oct. 1964 p 2623–2626
(NASA-TT-F-11723) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Time displacement during air travel causes an interruption of the nychthemeral cycle, which in turn causes biological ill-effects. Commercial flying crews experience mainly fatigue and digestive disorders. The best ways for overcoming these two ill-effects are discussed. Author

N68-34013*# San Jose State College, Calif. Dept. of Psychology.
FACTORS INFLUENCING THE PERCEPTION OF ANGULAR ACCELERATION IN MAN Semiannual Status Report
Brant Clark Aug. 1968 14 p refs
(Grant NGR-05-046-002)
(NASA-CR-96631; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 06S

The objective of this research was to investigate the nature of the perception of angular acceleration in normal men during and following rotation. Whereas the majority of the earlier studies have been primarily concerned with physical models and the physiological mechanisms of the semicircular canals, this project has been concerned with man's subjective reactions to angular acceleration. Using the MCRD and a psychophysical method developed at Ames Research Center, work has been carried out to determine the range of sensitivity for angular acceleration in normal men. In addition, the effects of duration of stimulation, presence of visual targets in the field, axis of rotation and suprathreshold stimulation by angular acceleration have been studied. The work has resulted in reports at two meetings; two studies are in the final stages of data collection and preparation of the reports is well advanced; and one thesis study is complete and submitted for publication while the other is in the final stage of writing. Author

N68-34016*# Research Triangle Inst., Durham, N. C. Engineering and Environmental Sciences Div.
BIOMEDICAL APPLICATIONS OF NASA SCIENCE AND TECHNOLOGY Final Report, 15 Jun. 1967–14 Jul. 1968
14 Jul. 1968 70 p refs
(Contract NSR-34-004-045)
(NASA-CR-96613; EU-349) CFSTI: HC $3.00/MF $0.65 CSCL 06S

An overview is presented on the activities of the three multidisciplinary Biomedical Applications Teams who are participating in efforts to facilitate the transfer of scientific and technological information to clinicians and medical researchers. In discussing the 24 technology transfers and the 12 potential transfers, the problem and the solution are detailed, the searching method and source of solution are identified, the actual or potential benefits resulting from the transfer are assessed, and the status of the transfer is given. Also listed are the active problems for which solutions are being sought. It is reported that 28 computerized information searches and search up-dates of the aerospace literature were performed. M.G.J.

N68-34176# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACADEMY OF SCIENCES OF THE USSR. NEWS: BIOLOGICAL SERIES
25 Oct. 1967 34 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSR, Ser. Biol. (Moscow), no. 3, 1967 p 339–350, 396–403
(FTD-MT-24-244-67; AD-671952)

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1. BIOCHEMICAL BASES OF THE REGULATION OF THE SPEED OF GROWTH OF MICROORGANISMS N. D. Iyerusalimskiy p 1–14 refs (See N68-34177 21-04)
2. THE DYNAMICS OF PULSE WAVES OF INTRACRANIAL PRESSURE DURING TRANSVERSE OVERLOADS UP TO 40 g Yu. Ye. Moskalenko, O. G. Gazenko, G. B. Vaynshteyn, and I. I. Kas'yan p 15–24 refs (See N68-34178 21-04)

N68-34177# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BIOCHEMICAL BASES OF THE REGULATION OF THE SPEED OF GROWTH OF MICROORGANISMS [BIOKHIMICHESKIYE OSNOVY REGULYATSII SKOROSTI ROSTA MIKROORGANIZMOV]
N. D. Iyerusalimskiy *In its* Acad. of Sci. of the USSR. News: Biol. Ser. 25 Oct. 1967 p 1–14 refs (See N68-34176 21-04)

The question of the kinetics of metabolic processes, lying at the basis of the biosynthesis of proteins and nucleic acids is examined. The speed of formation of these most important biopolymers determines the speed of cell growth. The dependence between the speed enzymatic reactions and the concentration of the components of these reactions is described by simple equations of the Michaelis-Menten type. Equations of a similar kind are applicable also for the characteristics of complicated, multistage biosynthetic processes. This is explained by the fact that the speed of such complex processes is determined by the speed of the individual enzymatic reactions which occur slower than the others and are "bottlenecks" of the given complex of reactions. That circumstance that the dependence between the composition of the medium and the vital functions of the microorganisms, including the growth of cells, in a number of cases can be described by simple equations facilitates very much the mathematical modeling of the microbiological processes and permits the conscious control of their behavior, by maintaining with this goal the corresponding conditions of cultivation. Author

N68-34178# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE DYNAMICS OF PULSE WAVES OF INTRACRANIAL PRESSURE DURING TRANSVERSE OVERLOADS UP TO 40 g [DINAMIKA PUL'SOVYKH VOLN VNUTRICHEREPNOGO DAVLENIYA PRI POPERECHNYKH PEREGRUZKAKH DO 40 YED]
Yu. Ye. Moskalenko, O. G. Gazenko, G. B. Vaynshteyn, and I. I. Kas'yan *In its* Acad. of Sci. of the USSR. News: Biol. Ser. 25 Oct. 1967 p 15–24 refs (See N68-34176 21-04)

The conducted experiments showed that during transverse loads up to 15 g the pulse waves of intercranial pressure (PW ICP) decrease in amplitude. This depends mainly on the decrease of the beat volume of the heart during such overloads, and, thus, the general hemodynamic shifts predominate over the disturbances in the system of intracranial blood circulation which by themselves would give a growth of amplitude to the PW ICP. An increase in certain experiments of the amplitude of the PW ICP during loads up to 10 g, observed in a number of experiments, apparently was connected with the predominant influence in these cases of the intracranial factors on the parameters of the PW. Increase of the PW ICP during growth of the overloads above 25 g (after they became inconspicuous on overloads of the order of 15 g) witnesses either about certain restoration of the hemodynamic parameters of pulmonary circulation, or about the appearance of the intrinsic pulsation of the blood vessels, synchronous with the rhythm of the heart. In the period of the aftereffect, there was observed a period

of growth of the PW ICP with characteristic simplification of their form, which was caused by residual hypoxia of the cerebral tissue after the overload. Author

N68-34245*# Pennsylvania State Univ., University Park. Dept. of Geochemistry and Mineralogy.
ABSORPTION OF PYRIMIDINES, PURINES AND NUCLEOSIDES BY Li, Na, Mg, and Ca MONTMORILLONITE (CLAY ORGANIC STUDIES 12)
G. E. Lailach, T. D. Thompson, and G. W. Brindley [1967] 26 p refs Presented at the 16th Natl. Clay Conf., Denver, 28–31 Aug. 1967 Submitted for publication
(Grant NGR-39-009-015)
(NASA-CR-89254) CFSTI: HC $3.00/MF $0.65 CSCL 06A

The absorptions of the biologically important purines adenine and hypoxanthine, the pyrimidines cytosine, thymine, and uracil, and the nucleosides adenosine, guanosine, inosine, cytidine, thymidine, and uridine by Li–, Na–, Mg–, and Ca–montmorillonite have been studied in aqueous solutions over a range of pH values 2-12. The initial organic concentrations were between 0.8 and 1.4 m.molar. The ratio clay to organic compounds was such that only up to 30% of the exchange capacity could be saturated by organic cations, but, depending on conditions, up to 100% of the available organic material was absorbed. The results show that absorption occurs primarily as a cation exchange reaction. Thymine, uracil, and their nucleosides are not absorbed under the experimental conditions. The absorption of the other compounds at various pH's depends on their basicity, their aromatic or non-aromatic character and the possible extent of the van der Walls interaction with the silicate layers. Author

N68-34380*# Stanford Research Inst., Menlo Park, Calif.
SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 6: PUBLIC HEALTH, MEDICINE, AND BIOLOGICAL RESEARCH
R. W. Prehoda Jul. 1968 87 p refs
(Contract NASw-1722; SRI Proj. MU-7227)
(NASA-CR-96811) CFSTI: HC $3.00/MF $0.65 CSCL 06E

Manned space missions have caused the normal healthy adult to be intensively studied, in contrast to past biomedical research which principally centered on adults suffering from disease. These base-line clinical data cover almost every environmental parameter, permitting deviations from the norm to be better measured in disease and also allowing optimum performance standards to be set in many occupations. The impact on biomedical research techniques has been a positive achievement, especially where nonspace R&D is conducted by groups also engaged in bioastronautics. The use of the computer and mathematical models for biological systems has been refined in space R&D and is now widely employed. The research technique transfer includes use of digital computer processing and enhancement of X-ray and microscope photographs in medical diagnosis. The transfer of specific hardware items developed for space programs or related research has been unexpectedly slow. There is a very serious time gap between the acceptance at the clinical testing level and the widespread distribution of the system in medicine where the user requirements are to be found. Author

N68-34400*# Battelle Memorial Inst., Richland, Wash. Pacific Northwest Lab.
COSMIC RAY INDUCED RADIOACTIVITY IN ASTRONAUTS AS A MEASURE OF RADIATION DOSE (a)
R. L. Brodzinski, N. A. Wogman, and R. W. Perkins 1 Sep. 1968 15 p refs
(Contracts NAS9-7095; AT(45-1)-1830)
(NASA-CR-73251; BNWL-SA-1921) CFSTI: HC $3.00/MF $0.65 CSCL 06R

The activity-dose energy relationships for ^{7}Be, ^{13}N, ^{22}Na and ^{24}Na activities induced in muscle tissue by proton bombardment were measured through the energy range up to 580 MeV. The relationship between radiation dose and induced activity for any given proton bombarding energy is defined. The determination of the radiation dose received by an astronaut from cosmic radiation of unknown energy by measuring the concentrations of the radioactive isotopes induced in his body is discussed. Author

N68-34420# Army Aeromedical Research Unit, Fort Rucker, Ala.
PAINTED HELICOPTER MAIN ROTOR BLADES AND FLICKER-INDUCED VERTIGO
James A. Bynum and John A. Stern (Washington Univ., St. Louis) Jun. 1968 22 p refs
(USAARU-68-11; AD-672514)

Painting the main rotor blades of UH-1 helicopters led to the question of the possibility of flicker-induced vertigo in formation flights involving these helicopters. In the first of two experiments designed to answer the question, subjective responses of 38 instructors and students were obtained and evaluated after their participation in formation flights in helicopters with painted blades. In the second experiment, 10 student pilots were screened from a group of 37 on the basis of their psychophysiological and subjective responses to photic stimulations in the laboratory. These ten then flew in formations while EEG, EOG, and eye blink data were recorded during the flight and they were debriefed immediately following the flight. Results of both experiments did not indicate the painted blades to be a source of flicker vertigo. Author (TAB)

N68-34494*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CURRENT RESEARCH ON REGENERATIVE SYSTEMS
Jacob Shapira, Adrian D. Mandel, Phillip D. Quattrone, and Nancie L. Bell 16 May 1968 9 p refs Presented at COSPAR 11th Ann. Meeting, Tokyo, 9–21 May 1968
(NASA-TM-X-61201) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Multiple studies directed toward the development of a regenerative life support system have shown that easily synthesized organic compounds and microbiological materials are potentially capable of being used as foods for long duration space missions. The organic compounds presently believed to offer the greatest potential are glycerol, simple glycerol derivatives such as triacetin, and formose sugars. Laboratory studies indicate that glycerol can be synthesized from formaldehyde which in turn is obtained by the direct catalytic oxidation of methane, a by-product of the Sabatier reaction used in the spacecraft atmosphere control system. Formose sugars are derived from the self condensation of formaldehyde. Mixtures of glycerol and triacetin have been shown to be suitable as a major component of diets fed to weanling rats for prolonged periods. *Hydrogenomonas eutropha* is the microbiological system under investigation. Nutritional evaluation of *Hydrogenomonas* bacteria has shown they are capable of supplying the total protein requirement of growing rats for prolonged periods. The potential and problems of these regenerative systems and the prospects for the accomplishment of a totally regenerative food system will be discussed. Author

N68-34521*# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
INDUCED RADIONUCLIDES IN ASTRONAUTS Final Report, 15 Jun. 1967–1 Sep. 1968
R. L. Brodzinski, N. A. Wogman, and R. W. Perkins 1 Sep. 1968 58 p refs
(NASA ORDER A-97095; Contract AT(45-1)-1830)
(NASA-CR-73252; BNWL-5314) CFSTI: HC $3.00/MF $0.65 CSCL 06R

Activity-dose energy relationships for Be 7, N 13, Na 22, and Na 24 activities induced in unshielded muscle tissue by

bombardment with protons of up to 680 MeV were measured. The relationship between radiation dose and induced activity for any given proton bombardment energy is defined and established for unshielded tissue samples the size of the thoracic region of a man. The determination of the radiation dose received by an astronaut from cosmic radiation of unknown energy by measuring the radioactive isotope concentration in his body is discussed. Two studies are briefly described which deal with measurement of induced radioactivity in humans irradiated for therapeutic purposes and measurement of cosmic ray neutron flux in high-altitude pilots. Tabulated data resulting from the experiments and a 67-title bibliography are included. K.W.

N68-34582*# Stanford Univ., Calif. Aeronautics and Astronautics Dept.

TRANSMISSION CHARACTERISTICS OF AXIAL WAVES IN BLOOD VESSELS

M. Anliker, W. E. Moritz, and E. Ogden (NASA, Ames Res. Center) Apr. 1968 38 p refs Presented at the SESA Spring Meeting, Albany, 7–10 May 1968

(Grant NGR-05-020-223)

(NASA-CR-98768; SUDAAR-343; SESA Paper-1350) CFSTI: HC $3.00/MF $0.65 CSCL 06P

For a thorough evaluation of the mathematical models used in the analysis of the behavior of blood vessels it is necessary to measure also the dispersion and attenuation of the axial and circumferential (torsion) waves. To this end a method has been developed to determine the phase velocities and damping of sinusoidal axial waves in the carotid artery of anesthetized dogs with the aid of an electro-optical tracking system. For frequencies between 25 and 150 Hz the speed of the axial waves was between 20 and 40 m/sec and generally increased with frequency, while the natural pressure wave travelled at a speed of about 10 m/sec. On the basis of an isotropic wall model the axial wave speed should, however, be approximately 5 times higher than the pressure wave speed. This discrepancy can be interpreted as an indication for an anisotropic behavior of the carotid wall. The carotid artery appears to be more elastic in the axial than in the circumferential direction. Author

N68-34619# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CHANGES IN THE WORK CAPACITY OF HUMAN MUSCLE AFTER EXPOSURE TO HYPOKINETIC CONDITIONS [IZMENENIE MYSHECHNOIRABOTOSPOSOBNOSTI POSLE PREBYVANIYA CHELOVEKA V USLOVIYAKH GIPOKINEZII]

N. I. Taranov and N. E. Panferova 24 Jan. 1968 9 p refs Transl. into ENGLISH from Fizol. Zh. (USSR), v. 51, no. 11, 1965 p 1351–1355

(FTD-HT-23-36-68; AD-672337)

The limitation of muscular activity that can occur during spaceflight impairs the functional state of the motor apparatus. The functional shifts in the muscular apparatus during dynamic work are characterized by more rapid fatigue. The quality of dynamic work decreases after man is exposed to limited muscular activity. The decrease is characterized by a decrease in the force of muscular contractions and a disturbance in the rhythmicity of the work. The bioelectric activity of working muscles increased by 1.5-2 times after a 1-3 day exposure to limited muscular activity. After a more prolonged exposure of man to muscular inactivity the bioelectric activity of the working muscles was reduced in comparison with control tests before the start of the experiment. Author (TAB)

N68-34625# Joint Publications Research Service, New York.

ORGANIZATION AND SIMULATION OF AN ACOUSTIC ANALYZER

V. A. Dolyatovskiy 23 Aug. 1968 14 p refs Transl. into ENGLISH from Modelirovaniye v Biol. i Med. (Kiev), v. 2, 1966 p 72–84

(JPRS-46275) CFSTI: HC $3.00/MF $0.65

Methods are presented for organizing and simulating an acoustic analyzer, which represents a complex information system consisting of three sections and having four successive neuronal switchings at different levels. The tympanic membrane represents the first section, or the receptor; the conducting section consists of hair cells and the first neuron; and cortical section is the third part of the analyzer. The cochlei nuclei contain the second neuron and approximately 90,000 cells with about 60 connections in each. Characteristics are noted for the corpus geniculatum mediale, containing the third neuron, and the corpora quadrigemina. On the basis of the organization postulated for these sections, a simplified model, proposed for processing information by the auditory system has the form of an electronic discriminating device. M.W.R.

N68-34630# Naval Submarine Medical Center, Groton, Conn. Submarine Medical Research Lab.

CARBON DIOXIDE RETENTION DURING PROLONGED EXPOSURE TO HIGH PRESSURE ENVIRONMENT Interim Report

Karl E. Schaefer, George F. Bond, Walter F. Mazzone, Charles R. Carey, and James H. Dougherty Apr. 1968 19 p refs

(SMRL-520; AD-672554)

In preparation for the SEALAB II project, three subjects were exposed for twelve days to seven atmosphere of pressure in an artificial environment composed of helium, oxygen, and nitrogen. Average ambient CO2 concentration was 17% surface equivalent. Resting respiratory minute volume was increased to twice normal and related to a proportional increase in tidal volume. Both oxygen consumption and CO2 excretion were elevated, resulting in a respiratory exchange ratio of 1.02. Alveolar CO2 and mixed expired CO2 were significantly higher during the exposure period. Urine CO2 excretion was markedly increased from the second day on throughout the exposure. Potassium, sodium and chloride excretion showed a transitory increase during the first four days. The pattern of urinary CO2 and electrolyte excretion reflected a response to higher CO2 load than that present in the atmosphere of the chamber during the test. All values returned to initial levels during the 27 1/2 hour decompression period. The observed CO2 retention is explained as the summation of increased respiratory work indicated in the 38% reduction in maximum breathing capacity, accumulated CO2 in the chamber atmosphere, and respiratory pattern of trained divers serving as subjects. In regard to the increased CO2 production, an additional factor of possible metabolic alterations is suggested. A stress response was indicated in the increased blood corticosterone levels and elevated excretion of ketosteroids. The PO2 level of 200 mm Hg did not produce any change in hemoglobin or hematocrit. Author (TAB)

N68-34656# Defence Research Medical Labs., Toronto (Ontario).

THEORETICAL ASPECTS OF THE ROLE OF ANGULAR ACCELERATION IN VESTIBULAR STIMULATION

R. S. Weaver [1968] 38 p

(RP-565)

Various types of acceleration are systematically considered, and it is shown that turntable accelerations generally consist of several components, each readily calculable. The equations of motion are applied to the human vestibular apparatus when undergoing acceleration. Turntable experiments and the physical effects of the associated motions are analyzed, with emphasis on the forces experienced by the semicircular canals. The applicable vector algebra is developed, and equations of motion are derived in vector form. Graphs and a nomograph are presented for evaluating the results of centrifugal acceleration. K.W.

N68-34866*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BLOOD CHANGES IN ACUTELY SPLENECTOMIZED RATS DURING PROLONGED HYPEROXIC EXPOSURE
H. A. Leon, G. A. Brooksby, M. J. Chackerian, and R. W. Staley May 1968 2 p refs Presented at the 39th Ann. Sci. Meeting of the Aerospace Med. Assoc., Bal Harbour, Fla., 6–9 May 1968
(NASA-TM-X-61195) CFSTI: HC$3.00/MF$0.65 CSCL 06C

Preliminary experiments to show the effect of oxygen on circulating red blood cells in splenectomized male rats were conducted. Exposing these rats to oxygen at pressures from 600 to 258 mm Hg consistently changes hematocrit, total hemoglobin, and osmotic fragilities of red blood cells, indicating that the circulating red cell mass was decreased by an active removal of the older or more fragile cells. These changes were observed within three days. Methemoglobin and serum bilirubin show no deviation from those of the control rats. Osmotic fragility was determined in saline concentrations from 0.2% which caused 100% hemolysis, to 0.55% where lysis was negligible. The greatest decreases in fragility occurred in the higher saline concentrations. B.P.

N68-34711# Army Biological Labs., Fort Detrick, Md.
THE USE OF DARK-FIELD ILLUMINATION IN THE ELECTRON MICROSCOPE FOR MICROORGANISM STRUCTURE STUDY
G. P. Petrova and K. A. Ponomarev Jul. 1968 6 p refs Transl. into ENGLISH from Mikrobiologiya (Moscow), v. 28, no. 5, 1959 p 777–782
(TRANS-440; AD-672105)

With the assistance of the accessories that were installed in the electron microscope EM-3 it is possible to receive a dark-field illumination of a given area of an object and to change it to a bright field of the same area in short period of time. The dark-field method in electron microscopy is perspective for investigation of the internal structures of bacterial cells. In the dark field the difference in the character of the electron diffusion by the bodies of the gram-positive and gram-negative bacteria is clearly shown. It is expressed in that the gram-positive and gram-negative forms appear dark in the bright field, whereas in the dark field the gram-positive forms are dark and the gram-negative bright. A combination of the methods of investigating an object in the dark and bright field gives a more complete representation of the objects structure than either of them can give separately. Author (TAB)

N68-34773*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXTRATERRESTRIAL BIOLOGY: PROSPECTS AND PROBLEMS
Harold P. Klein [1968] 42 p refs Presented at the 4th Intern. Symp. on Bioastronautics and Exploration of Space, San Antonio, 24–27 Jun. 1968
(NASA-TM-X-61191) CFSTI: HC$3.00/MF$0.65 CSCL 06C

Two general arguments are presented to support the view that extraterrestrial life is widely distributed in the universe: (1) Life evolves from simple precursors when conditions on a planet favor the condensation of these materials to more complex substances. (2) Among the enormous number of stars in the universe, planetary systems and planets with suitable environmental characteristics will appear. As distance may restrict space travel to the solar system, the possibilities of finding life on these planets are assessed, with Mars considered as the best available target for conducting the search. The adaptation of organisms to environmental conditions is discussed, along with microorganism growth under simulated Martian conditions. Problems in planning life detection experiments are pointed out, and approaches to these problems are proposed. The scientific motivations and the interest of biologists in the search for extraterrestrial life are expressed. M.G.J.

N68-34779*# Houston Univ., Tex.
EXPERIMENTS AND OPERATIONAL PROCEDURES FOR DEVELOPING GERM-FREE SEEDS, SEEDLINGS, PLANTS, TISSUES AND CELL LINES FOR THE LUNAR RECEIVING LABORATORY Final Report
S. Venketeswaren 31 Aug. 1968 43 p refs
(Contract NAS9-6822)
(NASA-CR-92258) CFSTI: HC$3.00/MF$0.65 CSCL 06C

Botanical systems developed for the Lunar Receiving Laboratory (LRL) included 5 algae and 12 vascular plants; and analyses were made of algal growth, seed germination, seedling development, and establishment and maintenance of tissue cultures of the vascular plants. Blue-green, green, and red alga are currently being maintained as germ-free cultures in either solid agar media or in liquid cultures. Callus tissue of many of the higher vascular plants were established, and histological analysis of some of these tissues was performed. A strain of corn tissue derived from the lateral roots axis maintained a diploid condition, and electron microscope observations revealed a parietal layer of cytoplasm with normal structure of nucleus and other organelles. There were numerous double-membered organelles containing darkly stained storage products of possible starch or lipid composition. Details of the cultures are included for all the systems. M.W.R.

N68-34802*# Institute of Modern Languages, Inc., Washington, D. C.
PULMONARY SCINTIGRAPHY IN LUNG EDEMA [LUNGENSZINTIGRAPHIE BEI LUNGENEMBOLIE]
H. Rossler NASA Aug. 1968 3 p ref Transl. into ENGLISH from Schweiz. Med. Wochschr. (Basel), v. 98, no. 23, 1968 873 p
(Contract NASw-1693)
(NASA-TT-F-11902) CFSTI: HC$3.00/MF$0.65 CSCL 06E

Presented is an assessment of two pulmonary scintigraphic techniques used in diagnostic examinations of patients suspected of having lung edema. The two methods evaluated were (1) inhalation scintigrams, and (2) vascular or perfusion scintigrams. Both methods were simultaneously applied during a study involving 73 patients of the Baylor University College of Medicine and of the Ben Taub General Hospital in Houston, Texas. On the basis of these studies it is concluded that scintigraphic findings are adequately safe for instituting anti-coagulation therapy, or for a ligature of the V. cava; however, a pulmonary embolectomy should not be undertaken without positive evidence of embolism in the angiorgram, which can, if necessary, be obtained during the operations. S.C.W.

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N68-33655 Illinois Univ., Urbana.
VISUAL FACTORS AFFECTING THE PRECISION OF COORDINATE MEASUREMENT IN AEROTRIANGULATION
Desmond Conroy O'Connor (Ph.D. Thesis) 1967 266 p
Available from Univ. Microfilms: HC $12.15/Microfilm $3.45
Order No. 67-11894

This investigation has as its aim a study of the precision of centering black circular measuring marks in sharp circular targets simulating artificial pass points with homogeneous backgrounds of different contrasts, imaged in the vicinity of the fovea centralis. The task has been related to the general area of visual acuity, and the results confirm that the eye is remarkably sensitive to tasks of this type, threshold pointing standard deviations of the order of 0.5

seconds of arc having been obtained. The investigation goes further than recent photogrammetric tests using comparators with a least count of the order of 1 micron, which subtends a visual angle of 10 seconds at magnification 12x. Special instrumentation involving 6 meter viewing was used, with a least count of the order of 0.02 seconds of subtended angle. The results demonstrate that the precision of pointing to artificial pass points in aerotriangulation may be significantly affected by the size relationship between the measuring mark and pass point, the background density, and the adaptation level. Dissert. Abstr.

N68-33936*# Stanford Univ., Calif. Inst for Mathematical Studies in the Social Sciences.

SEARCH AND RETRIEVAL PROCESSES IN LONG-TERM MEMORY

Richard M. Shiffrin 15 Aug. 1968 138 p refs

(Grant NGR-05-020-244)

(NASA-CR-96549; TR-137) CFSTI: HC $3.00/MF $0.65 CSCL 05J

A theory of storage and retrieval in long-term memory is presented; and applications and extensions are discussed in terms of recognition and recall, ranking, second-guessing, interference phenomena, and latencies exhibited in two experiments. The first deals with the probabilistic nature of retrieval and the forgetting of individual items; the second with intrusion phenomena in responding and with interference phenomena following the altering of the response assigned to a stimulus. It was found that second-guessing probability could be considerably above chance even when responses ranked after the first choice were correct at the chance level; and this was interpreted to imply that the subjects used a retrieval strategy which outputs the first acceptable response covered in the memory search. Second-guessing is based on an additional search of memory and may, therefore, be above chance. Any model that assumes a long-term absorbing state is not considered appropriate for representing the memory process in such cases. An overall proactive effect was found to be present for both the probabilities of a correct response and an intrusion. The model used emphasized an ordered search through a small subset of stored codes. M.W.R.

N68-33975 Oregon Univ., Eugene.

ANALYSIS OF LINE LENGTH BY THE HUMAN VISUAL SYSTEM

Thomas Lloyd Harrington (Ph.D. Thesis) 1967 84 p

Available from Univ. Microfilms: HC $4.40 /Microfilm $3.00 Order No. 67 67-16164

Subjects were required to find, as quickly as possible, a long line in an array of randomly oriented short lines. These short background elements were of uniform length, but of different widths. One-third had the same width as the long element, one-third the same shape and one-third the same area. Thus the subjects were prevented from searching out the long element on the basis of these characteristics, which normally vary with length. The area of the array, the number of elements in it and the size of the elements all were varied to determine how these parameters affect the obviousness or distinctness of the long element. Latencies were taken and ratings of the obviousness of the long element were obtained from the subjects. It was found that the area of the field of elements had no effect on the distinctness of the disparate line. Decreasing the number of elements or increasing the size of the elements made the longer element stand out more emphatically. Dissert. Abstr.

N68-34009# Royal Aircraft Establishment, Farnborough (England).

A TEMPERATURE SENSING SUIT

C. B. Bolton and R. E. Simpson Nov. 1967 13 p

(RAE-TR-67280) CFSTI: HC $3.00/MF $0.65

This report describes a temperature sensing garment which, by changes of electrical resistance with temperature, permits measurement of skin or skin micro-climate temperature to be taken with reasonable reproducibility. It is sufficiently robust to be used during field trials and has fair accommodation to wearers of differing stature. The same methods of construction could probably be used for an electrical resistive heating garment. Author (ESRO)

N68-34044*# Allis-Chalmers Mfg. Co., Milwaukee, Wis. Advanced Electrochemical Products Div.

DESIGN AND FABRICATION OF A WATER ELECTROLYSIS UNIT FOR AN INTEGRATED LIFE SUPPORT SYSTEM Final Report, 6 Aug. 1966–31 May 1968

A. P. Antony Aug. 1968 67 p ref

(Contract NAS1-6561)

(NASA-CR-66654) CFSTI: HC $3.00/MF $0.65 CSCL 06K

A four-man water electrolysis unit providing 8 pounds of oxygen per day is described. Tests included a 250 hour unit demonstration. Electrical efficiency was 76% based on average cell voltages and the 1.23 volts per cell theoretically required for water electrolysis. Total power input was 960 watts; 800 watts were used for electrolysis and the remainder for heaters and accessories. Power sources were 28 volt dc and 115 volt 400 Hertz. Oxygen and hydrogen purities were greater than 99.95% based on analysis by gas chromatograph and mass spectrometer. The unit design is based on zero-g requirements. Potassium hydroxide (KOH) at a nominal concentration of 35% is maintained in an asbestos matrix for electrolysis. Water feed is by vapor diffusion across the hydrogen gas passage. The unit consists of 3 modules of 16 cells each. Cell subassemblies are of laminated and bonded polysulfone with "O" ring seals to integral module manifolds for feed water and product gases. Unit weight was 160 pounds, volume 4.4 cubic feet. Significant reductions could be made in weight and volume for a flight-prototype unit. Author

N68-34262*# TRW, Inc., Cleveland, Ohio. Mechanical Products Div.

ON-BOARD AIRCRAFT OXYGEN GENERATING SYSTEM

R. J. Kiraly, A. D. Babinsky, and P. D. Quattrone (NASA. Ames Res. Center) 13 Sep. 1968 29 p refs

(Contract NAS2-4444)

(NASA-CR-73229) CFSTI: HC $3.00/MF $0.65 CSCL 06K

An on-board aircraft oxygen generation system is being developed. Oxygen is generated by water electrolysis and carbon dioxide is removed from the rebreather loop by an electrochemical carbon dioxide concentrator. The design objectives are to develop a safe, reliable, compact system which would replace the present LOX system, thereby minimizing the need for ground support facilities, and reduce time and effort required for servicing. The only periodic servicing required is to refill a water reservoir between flights. The system, with the rebreather loop, requires only the generation of oxygen at a rate equal to approximately 1.5 times that metabolically consumed by the user. This system is also applicable for use in closed environments such as spacecraft and submarines. This paper describes the oxygen system and its design. Projected sizes and weights for a fully-developed prototype are presented. Other applications are discussed. Author

N68-34324*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ANALYTICAL SIMULATION OF AN INTEGRATED LIFE SUPPORT SYSTEM

O. Karl Houck Jun. 1968 16 p refs Presented at the ASME Ann. Aviation and Space Div. Conf., Beverly Hills, Calif., 16–19 Jun. 1968

(NASA-TM-X-61232) CFSTI: HC $3.00/MF $0.65 CSCL 06K

A digital computer program which solves thermodynamic–chemical equilibriums of an integrated life support system (ILSS) is discussed and the system, which is simulated, is

described. Comparisons of ILSS test results with various simulation cases are made. Analytical trade-off studies for spacecraft atmosphere temperature and oxygen recovery are presented. Studies that have been made are fairly accurate and provide substantiation of life support research. Author

N68-34345*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AN IMPLANTABLE MULTI-CHANNEL TEMPERATURE TRANSMITTER
T. B. Fryer, C. M. Winget, and J. M. Pope [1967] 3 p refs Presented at the Conf. on Eng. in Med. and Biol., 20th Ann. Meeting, Boston, 13–16 Nov. 1967
(NASA-TM-X-61199) CFSTI: HC$3.00/MF$0.65 CSCL 06B

A multichannel transmitter suitable for the simultaneous measurement of four independent temperatures has been designed and constructed. The low power consumption and small size make this unit suitable for use in chronic implant experiments. The measurement of body temperature via radio telemetry has proved useful in many physiological experiments, especially the study of circadian rhythms where the animal must be monitored continuously without outside influences. Single-channel systems for this purpose have been reported and widely used. Because of the significant temperature gradients that exist in the body it was deemed desirable to measure a number of temperatures simultaneously for a more complete study of the mechanisms involved in circadian rhythms. Author

N68-34385# Aviation Safety Engineering and Research, Phoenix, Ariz.
CRASHWORTHINESS OF AIRCREW PROTECTIVE ARMOR
Joseph L. Haley, Jr., Clifford I. Gatlin, and James L. Schamadan Apr. 1968 132 p refs
(Contract DAAG17-67-C-0138)
(TR-68-57-CM; AD-672504)

The results of a test program conducted to determine the physiological effects of personnel armor on aircrew members exposed to an aircraft crash environment are presented. Emphasis was placed on the effects of armor as worn by air crews in current military operations. The program was divided into two major tasks. The first included a literature search to obtain design data on human injury simulation techniques, a conference to obtain information from a group of combat-experienced US Army medical helicopter crewmen on the impact behavior of the armor in observed accidents, and modifications to anthropomorphic dummies to effect recordings of mechanical injuries to vital body areas. The second task consisted of three types of dynamic tests: vertical drop tower tests, horizontal accelerator tests, and a full-scale helicopter crash test. Test results indicated that the potentially dangerous effects of the armor during a crash situation are relatively few. The most serious problem appears to be the possible collapse of the trachea following an impact of the upper edge of the armor with the front of the neck. Author (TAB)

N68-34419* National Aeronautics and Space Administration, Washington, D. C.
LIFE SUPPORT SYSTEM MANNED TESTING WITH OXYGEN AND WATER RECOVERY
A. L. Ingelfinger, T. C. Secord, (McDonnell-Douglas Co.), and W. F. Arndt, Jr. (McDonnell-Douglas Co.) [1968] 4 p ref Presented at the 1968 Ann. Aerospace Med. Assoc. Meeting, Bal Harbor, Fla., 6–9 May 1968
(NASA-TM-X-61179)

Test data are presented on the advanced life support system which was integrated and installed in the space cabin simulator for the crew to operate, repair, and maintain under conditions comparable to those encountered by an earth orbital laboratory. Major emphasis is placed on the water and oxygen regeneration systems. A wick evaporator system was used to regenerate water from urine and cabin condensate water from four crewmen; the water was used for drinking and reconstituting freeze-dried food. Results show that the completely automatic urine feed system and pretreatment functioned perfectly with no sign of wick flooding. Oxygen recovery was achieved by using a Sabatier reactor unit. The CO_2 was transferred from an improved regenerative molecular sieve system; the water from the Sabatier process was transferred to an electrolysis unit where O_2 was recovered and returned to the cabin, with the H_2 returned to the Sabatier unit. Also mentioned are the problems involved in trace contaminant and microbial control, and the piggy back equipment used in the experiment. M.G.J.

N68-34515# Honeywell, Inc., St. Paul, Minn. Research Dept.
A STUDY OF VISUAL SEARCH USING EYE MOVEMENT RECORDINGS: VALIDATION STUDIES Annual Report, 1 Jan.–31 Dec. 1967
L. G. Williams, W. H. Jack, W. D. Shontz, D. Hawthorne, and J. Juola 20 Jun. 1968 51 p
(Contract Nonr-4774(00))
(AR-3; Rept.-12009-IR-4; AD-672184)

The document covers a program of study of the visual search process. During previous experimentation, peripheral discrimination gradients have been determined for several stimulus attributes -- color, size, shape, and lightness. The present study attempted to validate the predictive capacity of the data base and a model of visual search. Two experiments were conducted. In the first experiment, subjects searched for information in a variety of actual map segments. The predictions were found to have very little relationship to the obtained search times. Several possible reasons for failure of the model are discussed. In the second experiment, predictions were made of the time required to find targets in relatively unconstrained abstract fields containing many objects of different size or different color. Here the models predictions were quite precise. It was concluded that, for accurate prediction of search times in complex situations, as represented by information to be located in maps, more information is required about two aspects of the search process -- the effect of target visibility and the peripheral discriminability of alphanumerics. Author (TAB)

N68-34525# National Academy of Sciences–National Research Council, Washington, D. C.
VISION RESEARCH: FLYING AND SPACE TRAVEL
Milton A. Whitcomb, ed. and William Benson, ed. 1968 221 p refs Proc. of Spring Meeting, 1964
(Contract Nonr-2300(05))
(AD-669266) CFSTI: HC$3.00/MF$0.65

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15. A FLASH BLINDNESS INDOCTRINATION AND TRAINING DEVICE J. F. Parker, Jr. (Biotechnology, Inc.) p 140–142 (See N68-34540 21-05)

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18. OPERATIONAL PROBLEMS ASSOCIATED WITH LOW-ALTITUDE FLIGHT R. W. Bailey (Army Aeromedical Res. Univ.) p 176–179 refs (See N68-34543 21-05)

19. SOME OPERATIONAL ASPECTS OF VISUAL PROBLEMS IN LOW-FLYING, HIGH-SPEED AIRCRAFT R. L. Jones and J. S. Joska (Air Proving Ground Center) p 180–197 refs (See N68-34544 21-05)

N68-34526# Michigan Univ., Ann Arbor. Sensory Intelligence Lab.

CRITERIA FOR LABORATORY EXPERIMENTS USEFUL IN FIELD SITUATIONS

Wilson P. Tanner, Jr. *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 3–15 refs (See N68-34525 21-05)
(Grant AF-AFOSR-367-63)

An explanation of the establishment of criteria for the design of laboratory experiments useful to field situations is presented. The first step, that of describing the current state of knowledge, is accomplished by stating a set of possible hypotheses to which an associated probability or degree of belief is assigned. The space in which these hypotheses exist is then described in terms of a set of orthogonal dimensions spanning the spaces. The size of the experiment necessary to assign coefficients to the orthogonal dimensions within a predetermined level of confidence is then determined. The procedure is illustrated in an experiment on memory in psychophysical tasks, and the problem of the interpretation of data obtained from experiments on vigilance is discussed. In conclusion, it is reemphasized that the most important factor is a precise statement of the problem to be studied. Author

N68-34527*# Presbyterian Medical Center, San Francisco, Calif. Eye Research Inst.

VISUAL FITNESS FOR SPACE TRAVEL

Arthur Jampolsky, Ailene Morris, and Carter Collins *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 16–18 (See N68-34525 21-05)

Challenges currently presented in experimental determinations of visual fitness criteria and selection standards for space travel are assessed. Focused on are problems related to determining (1) the visual capabilities that are required for space travel; (2) how to provide for unpredictable stresses on an already overloaded man confronted with a mortal dilemma; and (3) how to evaluate and select the man who can meet novel and unknown crises which may involve critical visual performance. To overcome these inherent problems it is proposed that (1) new tests be developed that are adapted to dynamic stress situations rather than to static situations, and (2) these tests be focused on what should be done rather than what can be done. S.C.W.

N68-34528*# Lockheed Missiles and Space Co., Sunnyvale, Calif.

THE EFFECT OF FLASH DISTRIBUTION AND ILLUMINANCE LEVEL UPON THE DETECTION OF LOW INTENSITY LIGHT STIMULI

Richard E. Wienke *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 19–30 refs (See N68-34525 21-05)
CSCL 05H

The proportion of light flashes detected by naive subjects was determined as a function of two flash groupings and two levels of flash intensity. One flash grouping, the "massed" condition, consisted of two groups of six flashes. The flashes were presented at the rate of 1 flash/sec with about 1° of arc separations. The groups were separated by approximately 90 sec of time and 90° of arc. The second, or "distributed" condition, consisted of 12 flashes presented at the rate of 1 flash/each 10° of arc and 10 sec of time. The illuminance-level of these two conditions was equivalent to 0.13/kmc. One group of subjects was run under the distributed condition when the illuminance was increased to 0.935 kmc. There was no significant difference in the proportion of subjects detecting flashes where flash distribution was the independent variable. A greater proportion of flashes was seen under the distributed condition than under the massed condition. More subjects made detections when the stimulus was 0.935 kmc than when it was 0.13 kmc. Author

N68-34529*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LANGLEY RESEARCH CENTER SIMULATORS AND STUDIES RELATED TO SPACE RENDEZVOUS AND DOCKING

Jack E. Pennington *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 31–39 refs (See N68-34525 21-05)
CSCL 05H

Summarized are research efforts resulting in the development of visual rendezvous simulators, rendezvous docking simulators (RDS), and visual docking simulators (VDS) for improving pilot capabilities, minimizing system requirements, and increasing the probability of mission success during Gemini-Agena and future Apollo spacecraft maneuvers. Visual rendezvous simulators were used in studies of the acquisition phase of visual rendezvous, and coplanar rendezvous closure control. Studies made using the VDS included the effects of control modes (direct command and rate command) on the pilot's control of docking, and docking problems arising from target lighting under daytime and nighttime lighting conditions. Studies of visual-aid techniques that could be added to the Gemini-Agena without major modifications, reduce inaccuracies, and increase pilot's confidence, particularly in the darkside (night) docking were made using both the VDS and the RDS. The RDS was also used to evaluate the suitability of the Agena Target Docking Adapter (TDA), and the effect of thruster failure on the pilot's control of docking. Other studies made with the simulators included: a technique for manually determining range and range

rate during rendezvous; evaluations of Gemini cockpit instruments and controllers; techniques for reducing control cross-coupling by canting the translation jets; and remote controlled docking using closed circuit television. S.C.W.

N68-34530# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SOME LANGLEY RESEARCH CENTER PLANS IN THE AREA OF VISUAL DISPLAYS FOR LUNAR MISSION SIMULATION
Donald R. Riley and Byron M. Jaquet *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 40-51 (See N68-34525 21-05) refs

Simple guidance techniques for pilot control of various tasks associated with the lunar mission are examined using analytical and simulation approaches. These simplified techniques and pilot utilization are directed towards increasing the reliability of Project Apollo and other manned space missions. Results of simulator studies have shown that, given proper information, pilots can perform rendezvous and docking, although these missions have not actually been performed in space. The usefulness of simulator devices, however, has been demonstrated in Project Mercury. Simulation devices such as LOLA (Lunar Orbit and Landing Approach) and the Lunar Landing Research Facility will provide information necessary for the lunar and other space programs. Author

N68-34531*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
VISUAL MASKING USING DIFFERENT TEST STIMULUS PATTERNS
Robert C. Boyle *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 52-61 refs (See N68-34525 21-05) CSCL 05H

A visual masking experiment is described which was designed to demonstrate the relationship between human visual perceptual latency and object luminance during high velocity flight. In this study the term visual masking refers to the gradual reduction of correct responses as to the orientation of a patterned test stimulus as the temporal interval between the test stimulus and a succeeding brighter masking stimulus is decreased. A latency model of visual masking is used to explain obtained results. The thesis of the experiment is that even though the constants of an equation based on a latency model of visual masking may vary some with different test-stimulus patterns, the variation, despite its significance, will be relatively minor and the equation will retain its general latency form. Studied were three subjects, Naval personnel, who were trained on three test stimuli over a two-week period. Throughout the experiment each subject used only the right eye. Subjects were tested using a test-stimulus positioning servo system. Stimuli consisted of three equal area stimuli, a blanking flash stimulus, and a fixation pattern. Each subject's task was to identify the position (up, down, left, or right) of the test stimulus. Preliminary data show that visual masking decreases as test flash luminance is increased or as the interval between the test flashes and blanking flashes is increased. It is concluded that observed visual latencies could have important ramifications for the operation of very high velocity spacecraft, and that in view of these findings traditional concepts of pilot observation of the external environment should be modified. S.C.W.

N68-34532*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SEXTANT SIGHTING PERFORMANCE IN THE AMES MIDCOURSE NAVIGATION AND GUIDANCE SIMULATOR
Robert J. Randle and Bedford A. Lampkin *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 62-70 refs (See N68-34525 21-05) CSCL 05H

Described is a lunar midcourse navigation and guidance simulator which is being used to study the role of the crew in spacecraft navigation, guidance, and control during translunar or midcourse flight. Major features of the simulator and results of an exploratory study of sextant (hand-held and gimbal mounted) sighting performance of three Air Force navigator instructors in a simulated task environment (celestial visual scene) are reviewed to demonstrate the capabilities of the simulator as a research device for visual problems. S.C.W.

N68-34533# California Univ., San Diego. Scripps Inst. of Oceanography.
COMMENTS ON MAJOR GORDON COOPER'S OBSERVATIONS FROM ORBIT
John H. Taylor *In* NAS-NRC vision res.: Flying and Space Travel 1968 p 71-79 (See N68-34525 21-05)

The Mercury series of manned earth-orbital space flights ended with the mission referred to as MA-9, piloted by Major L. Gordon Cooper. During certain of the 22 orbits, Major Cooper reported having seen objects on the surface of the earth that must necessarily have subtended very small visual angles from the capsule. In view of the immediate and vociferous reaction on the part of the scientific and lay communities as to the validity of Major Cooper's sightings, a controlled experiment was conducted to assess the ability of the Gemini astronauts to discriminate ground features. This ex post facto visibility problem was examined as follows: (1) four specific reported sightings (El Centro and El Paso California, the high Tibetan plateau, and western China) were studied which combined atmospheric transmission data, known visual performance capabilities, and both measured and assumed properties of the objects purportedly seen; and (2) for each of the four cases investigated, pertinent excerpts are given from Major Cooper's statements. On the basis of these studies it is concluded that: (1) the terrestrial objects reported by Major Cooper from the Faith 7 capsule could have been seen under the conditions that have been assumed to have prevailed during the MA-9 mission; and (2) the fact that Major Cooper is a superior observer and highly experienced in high altitude observation indicates that estimates of the performance of an observer in a real life situation that are based on laboratory data may be conservative. S.C.W.

N68-34534# California Univ., San Diego. Scripps Inst. of Oceanography.
GEMINI IN-FLIGHT VISUAL-ACUITY EXPERIMENT
S. Q. Duntley *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 80-82 (See N68-34525 21-05)

The design of a controlled experiment which will test existing methods of predicting the visual capabilities of human observers in space is reported. The experiment is designed (1) to determine under carefully documented conditions the effects of prolonged weightlessness, 5 PSI oxygen breathing, and other environmental conditions peculiar to space flight on the astronaut's visual performance capabilities as a function of time; (2) to obtain information by measurements prior to flight on the visual capabilities of the astronauts who will be involved in the seven day or longer missions; and (3) to measure (in flight) astronaut performance in two visual tasks. The astronauts involved in missions GT-5 and GT-6, and/or GT-7 will be required to measure their own visual acuity during the mission with the aid of an in-flight vision tester. The task will involve the use of the tester by each man once a day throughout the flight. The in-flight vision tester will be completely self-contained and require no interfaces with the spacecraft other than stowage. In addition, during orbits which pass within range of a prepared ground target area, the astronaut in the right hand seat will determine the orientation of each of approximately 12 rectangular targets. The astronaut will make a binary-type decision which will be recorded on a card. The card which is removable will contain the results of the vision tests which will be read by the astronaut either into his tape recorder or directly by radio link to the ground. S.C.W.

N68-34535# Bureau of Medicine and Surgery, Washington, D. C.
OPERATIONAL SIGNIFICANCE OF THE FLASH BLINDNESS PROBLEM
Walton L. Jones *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 85–94 (See N68-34525 21-05)

The operational significance of flash blindness is discussed in view of its effects on performance capabilities of Navy aviation personnel engaged in activities for which the maintenance of effective vision is critical, i.e., low level daylight attack, night formation flights, and carrier night deck operations. It is shown that as the problem of flash blindness is placed into operational perspective, in certain respects it poses a more serious problem than those produced by the blast, shock, and thermal radiations from nuclear weapons. Major efforts of a Navy program focusing on protective devices and procedures for minimizing the hazards of flash blindness phenomena are reviewed. Program efforts include: (1) laboratory investigations of visual impairment from exposure to high intensity light sources; (2) collection of data for a model allowing prediction of flash blindness hazard in operational environments; (3) development and evaluation of flash blindness protection devices; and (4) preparation of training and indoctrination materials for pilots. S.C.W.

N68-34536# Naval Air Development Center, Johnsville, Pa. Aviation Medical Accelerator Lab.
THE NATURE OF RADIATION FROM NUCLEAR WEAPONS IN RELATION TO FLASH BLINDNESS
J. H. Hill and Gloria T. Chisum *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 95–103 refs (See N68-34525 21-05)

The rate of emission of thermal radiation from a nuclear weapon detonated at low altitude is evaluated in an attempt to provide information on the nature of radiation in relation to flash blindness; and to provide guidelines for the design of adequate flash blindness protective devices consisting of the luminance, duration, and visual angle subtended by the source. It is assumed that, except for their eyes, personnel can be adequately protected up to the point at which they would receive second degree burns. On the basis of this assumption, the concept of equal effects of nuclear weapons regardless of weapon size is used to estimate fireball luminances for five weapon yields. Using these estimates, predictions are made of factors as: (1) the integrated luminances which would be received by the eyes, protected only by the blink reflex, and by some of the protection devices under development; (2) the extent of the retina covered by the image of a fireball; and (3) the effect of fireball luminance on other surfaces within the visual field in the event that the fireball itself is not imaged in the retina. It is shown that the integrated luminance received from a surface with 10% diffused reflectance can be over 5 log mL-sec if no protective measures but the blink reflex are used; and (2) this luminance is sufficient to cause flash blindness hazardous to a pilot. Qualitative comparisons are made of rates of arrival of thermal radiation at a given distance from high altitude and sea level bursts. S.C.W.

N68-34537# Pennsylvania Univ., Philadelphia. School of Medicine.
EXPERIMENTAL INVESTIGATIONS OF THE FLASH BLINDNESS PROBLEM
John Lott Brown *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 104–126 refs (See N68-34525 21-05)

Laboratory studies of flash blindness parameters which attempt to define how vision is impaired by exposure to unusually high energy levels in spectral and temporal patterns that are representative of those to be encountered from atomic weapons; are reviewed. Specifically considered are those parameters of paramount importance to the pilot of high performance aircraft, such as luminance and visual-acuity requirements. Examined are studies of the relation between the energy of blinding flash and the time required for detection of information in a visual display; the relation between luminance and recovery time; the distribution of adapting-flash energy in time and its effect on visual threshold; photochemical aspects of light adaptation; and spectral characteristics of flash and task illumination. Studies of additional variables that are of importance to understanding flash blindness phenomena as pupil size, differences in results (high variability) from one subject to another, and masking effects of the afterimage of the adapting flash; are also cited. Included is a review of quantitative formulations developed to study flash blindness effects. S.C.W.

N68-34538# Edgerton, Germeshausen and Grier, Inc., Boston, Mass.
METHODS OF PREVENTING FLASH BLINDNESS
Frederick E. Barstow *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 127–133 See N68-34525 21-05)

Discussed are nominal specifications of flash blindness protective devices; active (mechanical, polarization, and chemical-molecular) and passive (blink response, eye patch, and fixed filter) flash blindness protection methods; and advantages and limitations of a more specific method, the photochromic protective system, which is an indirectly actuated system requiring ultraviolet energy from flash tubes. S.C.W.

N68-34539# School of Aerospace Medicine, Brooks AFB, Tex. Ophthalmology Dept.
AIR FORCE EFFORTS IN THE FIELD OF FLASH BLINDNESS
James F. Culver *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 134–139 refs (See N68-34525 21-05)

Presented is a short summary and reference list of Air Force activities focusing on the development of systems and devices for protecting the eyes of flying personnel from thermonuclear induced hazards as flash blindness and chorioretinal burns. Cited are studies of the feasibility of using a fixed-filter eye protection system; design criteria for eye protection from nuclear flashes and prototype eye protective devices; and in-house studies of flash blindness which are designed to define the operational aspects of this problem and outline a training program. Areas under continuing development include: (1) phototropic, or so-called self-attenuating, filters which darken on exposure to ultraviolet and shortwave-length visible radiation; (2) indirectly activated phototropic filters activated by flash tubes; (3) dynocell phototropic filters which consist of highly sensitive phototropic fluids flowing through filter cells; and (4) electronic triggering systems for the indirectly activated filters. S.C.W.

N68-34540# Biotechnology, Inc., Arlington, Va.
A FLASH BLINDNESS INDOCTRINATION AND TRAINING DEVICE
James F. Parker, Jr. *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 140–142 (See N68-34525 21-05)

Described is a flash blindness indoctrination and training device which was developed to demonstrate to pilots who might operate in nuclear combat zones what would happen to their vision, and consequently, to their mission capability if they unexpectedly encountered the light from a nuclear burst. The device will serve the following two training functions: (1) indoctrination training, and (2) proficiency training. Basic elements of the flash blindness device are: flasher unit, focusing hemisphere; diffuser screen; pilot's instrument panel; and operator's panel. An important use of the device is to illustrate the dramatic decrease in visual recovery time which occurs when the illumination of the visual task is increased. Results of tests of several subjects in the proposed device are cited. Tabulated are the range of recovery times for two conditions of illumination of the visual task which consisted of reading three digits which were white against a black background, as soon as possible following the flash. S.C.W.

N68-34541# Human Factors Research, Inc., Los Angeles.
GEOGRAPHIC ORIENTATION DURING LOW-ALTITUDE FLIGHT
James J. McGarth *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 146–163 ref (See N68-34525 21-05)
(Contract Nonr-4218(00))

Summarized are results of a problem analysis effort which was designed to determine the need for geographic orientation research and the directions such research should take. Geographical orientation is defined as the pilot's awareness of his navigational position; however, studies are limited to those missions in which the pilot must fly at low altitudes under visual flight rules. Purposes of the research were: (1) to determine whether pilots under operational conditions become lost frequently enough to constitute a significant cause of mission failure; (2) to determine the role of human performance research in the study of geographical orientation and to establish the priority of research problems within this area; and (3) to evaluate possible experimental techniques to be used in solving the research problems. Results of these studies indicate that: (1) geographic disorientation does occur frequently enough in present-day aviation operations to affect significantly the success of these operations; (2) problem areas which make significant contributions to geographic disorientation are visual reference, dead reckoning procedures; aeronautical charts (selection and encoding of information); weather conditions; preflight procedures; and flight instruments; (3) checkpoint detection and identification play a key role in geographic orientation; and (4) techniques which provide either visual stimuli which are comparable to the visual conditions in the real world situation and/or methods which allow the pilot some form of mobility, as for example motion picture techniques, offer complementary methodological approaches to studies of geographic disorientation. S.C.W.

N68-34542# Autonetics, Downey, Calif.
DYNAMIC VISUAL DETECTION RECOGNITION
Charles P. Greening *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 164–175 refs (See N68-34525 21-05)

A scheme for relating complex dynamic properties of the visual system to other aspects of visual research is described; dynamic properties of the low altitude visual field (i.e., single-point geometry and extended-object geometry) are examined; and results of laboratory and flight test studies of dynamic target detection and recognition performance are reviewed. S.C.W.

N68-34543# Army Aeromedical Research Unit, Fort Rucker, Ala.
OPERATIONAL PROBLEMS ASSOCIATED WITH LOW-ALTITUDE FLIGHT
Robert W. Bailey *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 176–179 refs (See N68-34525 21-05)

Discussed are operational problems associated with low altitude flight in Army aviation, more specifically, nap-of-the-earth flying which is conducted in close proximity to the earth as a protective measure against enemy observation and weapons. Focused on are visual navigation problems which are directly related to apparent speed and effective line-of-sight distance. Other problem areas associated with flying nap-of-the-earth include: (1) the definite decrease in security and resultant increase in stress on the pilot due to his relative air-ground position; (2) differences in complexity of the task of flying low profiles between helicopter pilots and fixed wing pilots; and (3) visual streaming effects (at very low altitudes, e.g., 30 ft on flat terrain) which produce nausea in pilots flying at 250 knots. Included are results of two studies performed during extended low altitude flight which are pertinent to the human engineering deficit and the problem of navigation over unfamiliar terrain during flights flown nap-of-the-earth. S.C.W.

N68-34544# Air Proving Ground Center, Eglin AFB, Fla.
SOME OPERATIONAL ASPECTS OF VISUAL PROBLEMS IN LOW-FLYING, HIGH-SPEED AIRCRAFT
Robert L. Jones and James S. Joska *In* NAS-NRC Vision Res.: Flying and Space Travel 1968 p 180–197 refs (See N68-34525 21-05)

Inherent operational problems contained in the close-support and interdiction type missions into enemy territory which are associated with the use of low flying, high speed aircraft are discussed. Problems considered include navigation to the target area, search for the target, target acquisition, target recognition, tactical maneuvering, weapons delivery, and escape. Focused on are human factors aspects for both reciprocating-engine and jet aircraft pilots involved in achieving a first pass acquisition, recognition, and fire situation where the pilot might acquire, recognize, and destroy a target on a single pass; and results of flight tests which were designed to obtain data relating to the distance at which typical ground targets might be acquired and recognized during high speed, low altitude flight. The F-100 aircraft was used with 500 ft as the test altitude, and acquisition distances were obtained for speeds of 250, 350, 450, and 550 knots. Data on the relationship between airspeed and target acquisition distance, and run number and target acquisition distance are presented. Also reported is the initiation of another test to evaluate training techniques to improve the perceptual efficiency of pilots, and thus improve their capability for target acquisition and recognition. The techniques under evaluation involve use of linearly programmed photographs (ranging from low stimulus ambiguity to high stimulus ambiguity) of typical tactical targets which will be presented on a tachistiscopic teaching machine, allowing stimulus presentation speeds of 1 sec, 1/2 sec/ 1/10 sec, and 1/20 sec. S.C.W.

N68-34548*# Philco-Ford Corp., Palo Alto, Calif. Western Development Labs.
PHYSIOLOGICAL MONITORING TECHNIQUE USING UNATTACHED SENSORS
Mylen Fitzwater, dePaul Corkhill, Earl Jackson, Paul Halvorson, and Werner Sepper Mar. 1968 97 p refs
(Contract NAS12-121)
(NASA-CR-86048) CFSTI: HC $3.00/MF $0.65 CSCL 06B

As crews of future extended space missions will work in a shirt sleeve environment, research was undertaken to develop techniques and electronic instrumentation for electrocardiographic and body impedance change measurements without attaching or implanting sensors or electrodes. The physiological measurements made included heart biopotential waveforms obtained from electrodes placed on each arm; impedance respiration measured from palm to palm; impedance pulse measured from palm to palm; thoracic sounds picked up by a microphone placed in the mid-dorsal position; and galvanic skin response measured by impressing a direct current from palm to palm. The monitoring system consists of two palmar dry electrodes and a microphone as sensors; a set of solid-state modular signal conditioners designed to separate, filter, and amplify each channel of physiological information; and a strip chart recorder. Results obtained using palm-to-palm dry unattached electrodes were found to be comparable to those obtained using conventional methods, although further circuit design changes are planned. M.G.J.

N68-34549*# Stanford Univ., Calif. Inst. for Mathematical Studies in the Social Sciences.
COMPUTERIZED INSTRUCTION AND THE LEARNING PROCESS
Richard C. Atkinson 15 Sep. 1967 33 p refs Presented at meetings of the Am. Psychological Assoc., Washington, D. C., Sep. 1967
(Grant NGR-05-020-244)
(NASA-CR-96546; TR-122) CFSTI: HC $3.00/MF $0.65 CSCL 05J

The operating experience encountered in a computer-assisted instruction (CAI) reading program is reviewed. The data are based on working with a sizable group of first-grade children who received a major portion of their daily reading instruction under computer control. A tutorial approach was used as such programs have the capability for real-time decision making and instructional branching contingent on a single response or on some subset of the student's response history. Details are given on the development of the IBM-1500 instructional system which consists basically of a central process computer with accompanying disc-storage units, proctor stations, and an interphase to 16 student terminals. The CAI reading curriculum is discussed, along with the problems involved in developing the Coursewriter 2 computer language. Tables are included to show the audio messages and film pictures required for two sample problems along with the hypothetical addresses on the audio tape and film strip; and the computer commands required to present two examples of these problems, analyze the student's responses, and record his data record. M.G.J.

N68-34575# Federal Aviation Administration, Washington, D. C. Office of Aviation Medicine.

A RETROSPECTIVE ANALYSIS OF AEROMEDICAL CERTIFICATION DENIAL ACTIONS, JANUARY 1961–DECEMBER 1967

P. V. Siegel and Charles F. Booze, Jr. May 1968 12 p refs
(AM-68-9)

The study quantifies several unknowns and/or uncertainties with respect to medical and general descriptive attributes of airmen denied medical certification. Data are presented concerning age, sex, occupation, total flying time, and medical characteristics of denied airmen. Certification actions at the appellate level are discussed to include medical problems associated with appeals to the Federal Air Surgeon and the FAA Administrator. An analysis of mortality experience among airmen exempted from the regulations due to cardiovascular problems is also presented. Author

N68-34676*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MICROBIOLOGICAL STUDIES ON LIFE SUPPORT SUBSYSTEMS FOR MANNED SPACE FLIGHT

Judd R. Wilkins [1968] 19 p refs Presented at the Am. Ind. Hyg. Assoc., St. Louis, 13–17 May 1968
(NASA-TM-X-61209) CFSTI: HC$3.00/MF$0.65 CSCL 06K

A research test chamber to study and test critical life support subsystems for long duration space missions is investigated. This system is designed to support four men for 90 days without resupply. Critical life support subsystems include the recovery of water from urine, waste management, and personal hygiene. Microbiological studies in support of the development and testing of these subsystems are reported. Emphasis is placed on the microbiological problems associated with the recovery of water from urine using a wick evaporator system. Such factors as system sterilization, antimicrobial treatment procedures, and laboratory methodology to meet biological standards are discussed. Laboratory investigations associated with other life support subsystems are also presented. Microbiological results obtained during closed-door testing of the integrated life support system test chamber are reviewed. Author

N68-34665*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

INSTANT MODULAR 3D MOCKUP FOR CONFIGURING CONTROL AND DISPLAY EQUIPMENT

Charles C. Kubokawa May 1968 30 p refs Presented at the IEEE 9th Ann. Symp. on Human Factors in Electron., Washington, D. C., 6–7 May 1968
(NASA-TM-X-61196) CFSTI: HC$3.00/MF$0.65 CSCL 05E

The modular three-dimensional mockup technique is demonstrated to be the middleground between the user and the designer of the equipment. The mockup method helps the designer to see easily, without operational knowledge, what the operator is trying to convey. The method described is (1) an effective and necessary communication link between user and designer in equipment design; (2) versatile in application; (3) flexible in configuration and design; (4) economical in cost; and (5) a time saver in design development. Suggestions for use include: aircraft instrumentation panels, computer control consoles, home appliance control panel, radio–radar equipment. Author

N68-34674*# Serendipity Associates, McLean, Va.

THE PROBLEM OF OFF DUTY TIME IN LONG DURATION SPACE MISSIONS, VOLUME 2 Final Report

John W. Eberhard Oct. 1967 104 p refs
(Contract NASw-1615)
(NASA-CR-96721; TR-55-67-14(U), V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 05E

This study analyzes the available off duty time in long duration space missions and suggests ways to use it. The time allocated for off duty, sleep, work and contingencies in representative mission studies was evaluated relative to the best current estimates of time required for these activities. The evaluation showed that there was too little scheduled off duty time, yet there was an excessive amount of off duty time available during the deep space phases of the mission. Discretionary activity possibilities during off duty time for the mission were determined. A detailed analysis was performed of activity possibilities for long duration missions and of actual activities employed by both general and special populations. The best source of activity requirements was the activity regimes of isolated groups such as the scientist and Navy personnel during the wintering over period in the Antarctic. Finally, suggestions are made for handling the excessive off duty time and guidelines were developed related to the off duty time period and to the design of discretionary activities. Author

N68-34679# George Washington Univ., Alexandria, Va. Human Resources Research Office.

REVIEW OF CONCEPTS AND LITERATURE ON CONTINGENCY MANAGEMENT

Barrie Cassileth Jun. 1968 16 p refs *Its* Humrro Profess. Paper 15-68
(Contract DA-44-188-ARO(D)-2)
(AD-672484)

The paper reviews theoretical background and recent developments in contingency management. The contingency management approach applies psychological principles of reinforcement (reward) in attempting to manage behavior (or learning) by manipulating the immediate effects, or contingencies, occurring as a consequence of performance. A survey of related literature includes studies with the retarded, with deviant behavior, and with children. Author (TAB)

N68-34751*# Serendipity Associates, McLean, Va.

THE PROBLEM OF OFF DUTY TIME IN LONG DURATION SPACE MISSIONS. VOLUME 3: AN ANNOTATED BIBLIOGRAPHY

John W. Eberhard and Kristine T. Smith Oct. 1967 202 p
(Contract NASw-1615)
(NASA-CR-96737; TR-55-67-15(U), V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 05E

The bibliographic listings pertain to publications on the effects of off-duty time on special isolated groups and on the individual, mission requirements, sleep requirements, work opportunities, and possible and probable activities for off-duty time periods. The citations are arranged according to intact group studies classified as Antarctic, underwater, remote sites, and space flight; and studies and reviews relating to mission requirements, space flight factors, space simulations, sleep and work–rest cycles, leisure, laboratory, and small group factors. M.G.J.

N68-34809 Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
THE EFFECTS OF BODY THERMAL STATE ON MANUAL PERFORMANCE
J. A. Vaughan, E. A. Higgins, G. E. Funkhouser, and Elinore M. Galerston May 1968 12 p refs
(AM-68-13)

Thirty-six young men were exposed for 2 hours to environmental temperatures of 10°, 26.7°, or 48° C. Measurements of rectal and skin temperature, heart rate and respiratory rate were made, and average skin and average body temperatures were calculated. Manual performance consisted of standardized peg tests for hand and finger dexterity, and a written motor coordination test. Converted scores showed no significant differences in peg placing at any of the thermal states studied. Men exposed to the neutral environment scored highest in the finger dexterity tests, but values for motor coordination were greater in the heat than in the other two environments. These data suggest that coarse hand movements are independent of body thermal state, but that more discrete tasks involving hand and finger dexterity, and motor coordination, can be most efficiently performed in warmer environments which promote at least thermally neutral values of skin and deep body temperature.
Author

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N68-33629 City Univ. of New York.
THE ABSORPTION INDUCED ELECTRODE POTENTIAL PHENOMENON
Charles John Cante (Ph.D. Thesis) 1967 136 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-12556

The study of the absorption induced electrode potential phenomenon has been organized into three parts. In the first part, the case of an ionizable vapor, hydrogen chloride, injected into the nitrogen stream entering a Ag/AgCl (exposed blade)/HCl aqueous/AgCl/Ag (immersed wire) has been investigated. It was concluded that the absorption of HCl vapor on the exposed electrode creates a transient concentration cell. In the second part, 1-butanol vapors were injected into the nitrogen stream entering the cell Pt anode (exposed)/fresh nitrochromic solution/Pt cathode (immersed) at several applied potentials. The magnitude of the current which is a result of the oxidation of the alcohol depends on the nitrogen flow rate, the sign and the magnitude of the applied potential and the volume of vapor injected into the cell. In the final part, the system IO_3^-/I- (pH>7) has been used in the cell: Pt (exposed)/IO_3^-, I-/Pt (immersed) to detect acid vapors. A current is recorded which is proportional to the amount of iodine which formed, and is therefore also proportional to the amount of acid vapor.
Dissert. Abstr.

N68-33637 Indiana Univ., Indianapolis.
THE EFFECT OF BOND FORMATION ON ELECTRON SCATTERING CROSS SECTIONS FOR MOLECULES
Denis Alan Kohl (Ph.D. Thesis) 1967 94 p
Available from Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-15121

Since accurate molecular wavefunctions are not available, theoretical expressions for the electron scattering cross sections for molecules only formally include the effect of bond formation. Tavard and coworkers have shown that the effect is a general decrease in the scattered intensity at small scattering angles. If the scattering process is interpreted in terms of the first Born approximation, they also showed that the decrease in intensity as a function of scattering angle is quantitatively related to a number of molecular properties including the binding energy, the three-dimensional electron density and the radially symmetric part of the electron-electron density. Total differential scattering cross sections were obtained experimentally for molecular hydrogen, nitrogen and oxygen. The cross section for helium was also measured and compared with a calculated cross section to calibrate the apparatus.
Dissert. Abstr.

N68-33638 Princeton Univ., N. J.
FAR-INFRARED AND RAMAN STUDIES OF HYDROGEN BONDING
William Joseph Hurley (Ph.D. Thesis) 1967 126 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-13497

Far-infrared and Raman spectra have been obtained for many substituted phenols and a few miscellaneous compounds and the hydrogen bond stretching frequencies (ν_g) have been observed in the pure compounds. Previous difficulties in making assignments have been obviated by use of the following criteria, which provide confident identification of ν_g: (1) disappearance of the absorption when OCH_3 is substituted for OH; (2) absence of the band in the Raman spectrum; (3) observation of a broad asymmetric band contour. The spectra of phenols are particularly interesting in that ortho and para substituted phenol ν_g frequencies are approximately equal and somewhat lower than the meta absorption. However, molecules with an ortho substituent capable of forming intramolecular hydrogen bonds show an abnormally low (< 100 cm^{-1}) hydrogen bond stretching frequency. This is attributed to the perturbing effect of the neighboring substituent on the intermolecular hydrogen bond; the order of perturbation in the halophenols is F < I < Br < Cl.
Dissert. Abstr.

N68-33659 Harvard Univ., Cambridge, Mass.
THEORETICAL STUDIES IN MOLECULAR SPECTROSCOPY
Karl Frederick Freed (Ph.D. Thesis) 1967 145 p
Available from Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-14126

The coupling of angular momenta in molecules is discussed and van Vleck's method of reversed angular momentum is generalized to spherical tensor form. Degenerate perturbation theory is used to express molecular energy levels to the degree of accuracy required by molecular beam electric (or magnetic) resonance spectroscopy. The bending of triatomic molecules is used to illustrate the treatment of large amplitude vibrations in polyatomic molecules. Expansions about an ill-defined equilibrium configuration are avoided. The bending mode is separated from the low amplitude, high frequency stretching modes via an adiabatic approximation, and the rotational motion is separated from the bending vibration by solving the asymmetric rotor problem by the method of variation of constants. *Ab initio* Hartree–Fock calculations are combined with the analysis of perturbations observed in the optical spectrum of BeO to assign the lowest observed $^1\Sigma$ state as the ground state of that molecule.
Dissert. Abstr.

N68-33660 Delaware Univ., Newark.
DYNAMICS AND CONTROL OF TUBULAR CHEMICAL REACTORS
Clarence Ronald Simpkins (Ph.D. Thesis) 1966 257 p
Available from Univ. Microfilms: HC $11.70/Microfilm $3.35 Order No. 67-11735

Techniques are developed for calculating the exact frequency response of multivariable process systems which are described by linear time invariant models. Frequency characteristics are obtained directly from the process differential equations without knowledge of the process transfer functions. Application to lumped parameter systems and to cocurrent or countercurrent distributed parameter systems with or without axial dispersion is described. The complete set of frequency responses calculated for a jacketed tubular reactor

are presented. The complete set of Bode plots relating concentration and temperature of the effluent from a fixed bed adiabatic reactor to changes in feed concentration, temperature, and flow rate was obtained experimentally. The validity of a mathematical model for the reactor is confirmed by comparing the experimental results with frequency response curves calculated from the model. The model is then used to predict the effect that changes in design and operation parameters have upon dynamic behavior. Dissert Abstr.

N68-33667*# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Chemistry.
ISOTOPIC ENRICHMENT OF NITROGEN IN THE PHOTOLYSIS OF NO
C. F. Schmidt, R. R. Reeves, Jr., and Paul Harteck [1967] 8 p refs Presented at the Intern. Conf. on Photochem., Munich, Sep. 1967 Submitted for publication
(Grant NsG-261)
(NASA-CR-85116) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Photolysis of NO in the vacuum ultraviolet yielded N_2, O_2, NO_2, and N_2O. When the photolysis was carried out using the 1633 Å line of bromine, the N_2 initially formed was found to be enriched in nitrogen-15. The dependence of the enrichment on several parameters was studied, including temperature, pressure, the initial isotope ratio, and inert gases. The enrichment of the N_2 in $N^{15}N^{14}$ over N_2 14 produced in the photolysis was due to relatively more $N^{15}O$ being excited, and reacting before isotope scrambling occurred by energy transfer. Author

N68-33678 Columbia Univ., New York.
OVERPOTENTIAL CHARACTERISTICS AND KINETIC PARAMETERS FOR THE SIMULTANEOUS DEPOSITION OF NICKEL AND HYDROGEN ON CLEAN AND SOILED NICKEL CATHODES
Peter Anthony Danna (Ph.D. Thesis) 1967 187 p
Available from Univ. Microfilms: HC $8.60/Microfilm $3.00 Order No. 67-15482

Codeposition of nickel and hydrogen from a high pH Watts bath was studied using galvanostatic and potentiostatic techniques. Current efficiency data and Tafel line parameters were obtained for deposition on atomizer clean nickel cathodes and for nickel cathodes soiled with the equivalent of 5 monolayers of stearic acid. Current efficiency for nickel deposition was determined during the first fractions of a second of electrolysis by use of a galvanostatic pulse plating technique and gravimetric method of analysis. For atomizer clean nickel cathodes current efficiency was found to be a function of pulse time as well as total current density, and depending on these conditions, increased from 0% to 99% as total current density ranged from 5 to 100 ma/cm^2 and as pulse time varied from 2 msec to 10 sec. For nickel cathodes soiled with 5 monolayers of stearic acid the nickel deposition efficiency was found to be a function of current density, pulse time and total charge passed. Dissert. Abstr.

N68-33696 Texas A&M Univ., College Station.
THE BENDING POTENTIAL FUNCTION OF THE BENT XY 2 MOLECULE
Thomas Ullan-Salvador (Ph.D. Thesis) 1967 121 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-16479

The bending vibration of a bent triatomic molecule is treated theoretically by different methods. The purpose is to determine the bending potential for the excited electronic states of these molecules. The first method applies to molecules which are bent from the linear configuration by a barely large angle. The molecule is treated as a harmonic oscillator in the bending coordinate with small bending oscillations about the equilibrium angle. The second method of treating the bending potential is applicable to molecules which are bent from the linear configuration. The bending vibration and the rotation about the a axis are not regarded as separable. The potential is represented by a two dimensional harmonic oscillator potential with a two dimensional Gaussian superposed. The resulting potential has a circular minimum. The energy level problem is solved using the harmonic oscillator wave functions as a basis. Dissert. Abstr.

N68-33748 Oklahoma Univ., Norman.
ZEEMAN EFFECT IN THE MICROWAVE SPECTRA OF FREE RADICALS
Donald Rex Johnson (Ph.D. Thesis) 1967 126 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-15854

A microwave spectrometer has been constructed to study the molecular properties of free radicals and metastable species in the 10 to 40 Gc/Sec range. Much of the instrumentation on the spectrometer was designed specifically to fulfill the unique demands imposed by the short life times and low abundances typically encountered with these species. Particular attention has been paid to the development of a system for producing and handling the samples. A square wave magnetic modulation was developed to take advantage of the paramagnetic nature of free radicals. Good sensitivity and resolution was achieved with the Zeeman components in paramagnetic gases, making precise measurements of the Zeeman effects of free radicals possible. Dissert. Abstr.

N68-33760 Case Inst. of Tech., Cleveland, Ohio.
SPECTRAL STUDIES OF MANGANESE (III)
Thomas S. Davis (Ph.D. Thesis) 1967 152 p
Available from Univ. Microfilms: HC $7.20/Microfilms $3.00 Order No. 67-16071

The solution and solid state spectra of twelve representative manganese(III) complexes and the acidic, aqueous solution spectra of the manganese(III) ion were examined. In each case two bands in the near infrared and visible portions of the spectra were found under suitable conditions. The consequences of Jahn-Teller effects on manganese(III) complexes are discussed and the low-energy band (8-13.5 $\times$ 10^{-3} cm^{-1}) is assigned to the $^5E_g \rightarrow {}^5A_{1g}$ transition (for D_{4h} symmetry) in some cases. An infrared spectral examination of hydrogen bonding to various neutral *bis*, *tris*, and *tetrakis* β-diketone complexes in deuteroform, methanol, and water solutions was carried out. The site of the hydrogen bond is proposed to be the β-diketone oxygens. The effects of hydrogen bonding on the near-infrared and visible spectra of manganese(III) β-diketone complexes were examined. The polarized spectra of single crystals of $CrCl_2 \cdot 4H_2O$ mounted over pinholes was obtained at room temperature and at 17°K but it was not possible to assign the four bands found. Dissert. Abstr.

N68-33782 Catholic Univ. of America, Washington, D. C.
RAMAN SPECTRA OF SOME MOLTEN SALT SYSTEMS
John Thomas Kenney (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-15464

New and improved electrodeless discharge lamps for Raman spectroscopy were developed. These lamps were operated under pressure controlled conditions to give a more stable discharge and cleaner and more intense spectra than standard discharge lamps. By operating these lamps with a pressure of 1u to 4u radiation imprisonment was eliminated and unreversed resonance lines were emitted. The cadmium and rubidium lamps as rad sources were used for Raman studies of some colored fused salts. The Raman spectra of indium dichloride in the pure melt and 2 M and 4 M in the LiCl–KCl eutectic melts were obtained. The thallium and mercury lamps were used to examine difference bands in the Raman spectra of carbon tetrachloride and titanium tetrachloride. Dissert. Abstr.

N68-33785 Catholic Univ. of America, Washington, D. C.
A STUDY OF LINE SHAPE FOR CO INFRARED EMISSION LINES
James Anthony Dowling (Ph.D. Thesis) 1967 134 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-15448

The shape of several vibration-rotation lines of CO emitted by a C_2H_2–O_2 flame was investigated. An equivalent width measurement was made using an absorption cell of room temperature CO as an analyzer. Analysis of the data showed that line shapes could be fitted to a Voigt function with shape parameters between 1.0 and 1.5. A computer program was formulated to calculate integrated emissivities with a Voigt function line shape. The collision widths of the flame lines, as determined by the shape parameters, are in essential agreement with earlier room temperature measurements. The extrapolation of the widths measured at room temperature to high temperature has been shown to be reliable within the accuracy of this experiment ±15%. Dissert. Abstr.

N68-33814 Columbia Univ., New York.
THE ULTRAVIOLET BEHAVIOR OF CARBOXYLATE DERIVATIVES
Peter Joseph Orenski (Ph.D. Thesis) 1967 303 p
Available from Univ. Microfilms: HC $13.75/Microfilm $3.90 Order No. 67-15509

The effect of structure and solvent polarity on the ultraviolet absorption spectrum of saturated esters and acids, lactones, α,β-unsaturated esters and acids, and oximes was investigated. In particular, the position and intensity of two electronic transitions were followed. The symmetry-forbidden ($n \rightarrow \pi^*$) excitation characterized by its low intensity (ϵ = 60–100), its shift to shorter wavelengths (to the blue) with increasing solvent polarity, and the disappearance of its vibrational fine-structure in polar media. The allowed ($\pi \rightarrow \pi^*$) transition was characterized by its large extinction coefficient (ϵ = 10,000–15,000) and its shift to longer wavelengths (to the red) with increasing solvent polarity. Alkyl substitution on the α-carbon of saturated esters shifts the forbidden band to longer wavelengths mainly as a result of inductive effects. Substitution on the α-carbon of conjugated ethylenic esters red-shifts both the allowed and the forbidden transition, the effect on the former being about seven times greater. Dissert. Abstr.

N68-33835# Argentina. Comision Nacional de Energia Atomica, Buenos Aires.
OBTAINING 5 ACETAMIDE 2,4,6 TRIIODO-N-METHYLISOPHTHALAMATE OF SODIUM 1-131 [OBTENCION DEL 5 ACETAMIDO 2,4,6 TRIYODO-N-METILISOFTALAMATO DE SOCIO 1-131]
Jorge C. Alvarez (Comision Nacional de Energia Nucl., Mex.), Catalina S. Arriaga (Comision Nacional de Energia Nucl., Mex.), and Aldo E. A. Mitta 1968 7 p refs In spanish; ENGLISH Summary Prepared in cooperation with Comision Nacional de Energia Nucl., Mex.
(CNEA-229) CFSTI: HC $3.00/MF $0.65

A method is discussed for the labelling of sodium iodothalamate by interchange between ^{131}I and inactive sodium iodothalamate obtaining a radiochemical yield over 95% in only 10 minutes. Control and stability of the product is also studied.
Author

N68-33856 Colorado Univ., Boulder.
STUDIES OF ISOCYANATE AND HALIDE COMPLEXES OF COPPER (II)
Abdul Rehman Chughtai (Ph.D. Thesis) 1967 170 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-15027

Geometric isomers of isocyanato complexes of copper (II) were prepared using large cations like tetraphenylphosphonium and tetraphenylarsonium by allowing an alcohol-water solution of copper nitrate, potassium cyanate, and tetraphenylarsonium chloride or tetraphenylphosphonium chloride to crystallize on a large watch glass at room temperature. Two different colored (blue and greenish-yellow) crystals appear in different proportions in both cases, i.e., the blue form is predominant in the case of the tetraphenylphosphonium cation, while the greenish-yellow form is predominant in the case of the tetraphenylarsonium cation. When the tetraethylammonium cation is used, a green compound is obtained which seems to be a mixture of blue and yellow forms. All of these complexes when dissolved in chloroform or acetone form greenish-yellow solutions, and when these solutions are cooled to dry ice-acetone temperature they turn blue; when the solutions are allowed to come to room temperature or above room temperature, the bluish color changes to greenish-yellow and then to bright yellow. The change is readily reversible. Dissert. Abstr.

N68-33869 Columbia Univ., New York.
THE EFFECT OF STEARIC ACID FILMS ON THE OVERPOTENTIAL FOR HYDROGEN EVOLUTION ON COPPER
Mary Anne Farrell (Eng.Sc.D. Thesis) 1967 246 p
Available from Univ. Microfilms: HC $11.25/Microfilm $3.20 Order No. 67-12250

A galvanostatic technique was used to determine the activation overpotential-current density relation for clean copper electrodes and for copper electrodes on which a stearic acid film had been deposited. The electrodes were made from flat sheets of spectrographically pure copper; 0.1 N H_2SO_4 was the electrolyte. Careful experimental techniques were employed in preparation of the electrodes and electrolyte to avoid deposition of unknown contaminants on the electrode surfaces. The Tafel equation described variation of the activation overpotential with current density for clean copper cathodes in the experimental current density range (2×10^{-5} to 3×10^{-2} amp/cm^2). For clean copper cathodes at 25°C, the mean value of the transfer coefficient (α) was 0.47 and the mean value of the exchange current (i_o) was 4.5×10^{-7} amp/cm^2; these Tafel parameters agree with published values.
Dissert. Abstr.

N68-33871 Rice Univ., Houston, Tex.
CHARACTERISTIC VELOCITIES AND DISPERSION COEFFICIENTS IN LINEAR MULTICOMPONENT CHROMATOGRAPHY
Gernot Klauser (Ph.D. Thesis) 1967 116 p
Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-13091

Analytical expressions for the characteristic velocities and dispersion coefficients for a multicomponent chromatographical system are presented. The system consists of two phases which are in relative motion. Plug flow is assumed and the mass transfer and chemical reaction rates are finite. There may be an equation of state for each phase. The method of solution is similar to the one which has been used by Horn(1) in connection with the simple system in which only one component transfers between two phases. The method involves a perturbation technique and the use of the moment transformation. It is shown that the characteristic velocities depend on the equilibrium and the stoichiometry of the rate processes and are independent of the mass transfer and chemical reaction rates. The characteristic dispersion coefficients are shown to depend on the rate coefficients and the eddy diffusivities.
Dissert. Abstr.

N68-33874 Lehigh Univ., Bethlehem, Pa.
MEASUREMENT AND DIFFERENTIAL CAPACITY AND CHARGE DENSITY AT POLARIZED MERCURY/SOLUTION INTERFACES
Theodor Dietrich Eck (Ph.D. Thesis) 1967 167 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-14933

A new instrument based on an established voltage sweep principle has been designed for the measurement of differential capacity and surface charge density at the electrical double layer of a polarized mercury/electrolytic solution interface. Accuracy of the voltage sweep method for differential capacity measurements was ascertained by comparision to similar data obtained by means of a.c. bridge methods. Under careful experimental conditions, the accuracy of the measured differential capacities was better than 1% throughout a major portion of the potential range. This accuracy could be attained for aqueous electrolytic solutions in the 0.01 to 1.0 M concentration range. A comparison of the surface charge densities obtained by the voltage sweep method to those derived from a.c. bridge measurements indicated that better than 2% accuracy is attainable when interference from faradaic current is minimal. Knowledge of the potential of zero permits the determination of the value of charge at every potential. Dissert. Abstr.

N68-33900 Northwestern Univ., Evanston, Ill.
KINETICS AND MECHANISMS STUDIES OF THE REACTIONS OF SOME TRANSITION METAL COMPLEXES
Otto Alphonese Gansow (Ph.D. Thesis) 1967 135 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-15235

Exchange reactions of some *bis* complexes of the chromous, ferrous and manganous ions were studied. The ligands used were glycinate, sarcosinate and dimethylglycinate ions. Free ligand in the solution exchanges rapidly with the ligands coordinated to the metal ion. The rates of the exchange reactions were determined using an nmr line broadening technique, and results are discussed in the light of crystal field theory. A kinetic study of the acid hydrolysis dissociation of the trisorthophenanthroline and trisbipyridine complexes of the vanadous and chromous ions was performed using conventional and stopped-flow spectrophotometric techniques. The dissociation of the tris(2,2'-bipyridine)vanadium-(II) ion was seen to have a large dependence of rate on acid concentration, whereas this was not so for the other complexes studied. The kinetics of formation of some vanadium complexes were studied. Kinetics of formation of the $VO(SCN)^+$ and the $VO(bipy)^{2+}$ ions are discussed. The reactions are fast and a stopped-flow technique was used to follow the reactions. A possible mechanism for the formation of some vanadyl complexes is given. Dissert. Abstr.

N68-33906*# Pennsylvania State Univ., University Park. Materials Research Lab.
ABSORPTION OF PYRIMIDINES, PURINES, AND NUCLEOSIDES BY CO-, NI-, CU- AND FE (III)-MONTMORILLONITE (CLAY-ORGANIC STUDIES XIII)
G. E. Lailach, T. D. Thompson, and G. W. Brindley [1967] 23 p refs Presented at the 16th Natl. Clay Conf., Denver, 28–31 Aug. 1967 Submitted for publication
(Grant NGR-39-009-015)
(NASA-CR-89255) CFSTI: HC $3.00/MF $0.65 CSCL 07C

The absorptions of various pyrimidines, purines and nucleosides by Co-, Ni-, Cu-, and Fe(III)-montmorillonite were studied using aqueous solutions in the pH range 2 to 12, and organic concentrations between 0.8 and 1.4 m.molar. Under acidic conditions, absorption takes place by cation exchange and the absorption characteristics are similar to those of Ca-montmorillonite. In the weak acidic, neutral, and weak alkaline range, absorption is due to complex formation. At higher pH values, absorption decreases as formation of hydroxides takes place. The strength of absorption due to complex formation decreases in the order Cu >> Ni > Co and adenine ≥ hypoxanthine > purine >> 6-chloropurine. These four compounds form complexes with positions N-3 and N-9 as shown by comparison of their absorption isotherms with those of 7- and 9-methyladenine. Depending on the pH, divalent and (stronger) monovalent complexes may be formed. With adenosine no absorption due to complex formation was observed whereas 9-methyladenine formed weak complexes. Both compounds can form complexes with the amino group and N-7. Weak complexes were observed with cytosine, cytidine, inosine, and guanosine. Thymine, uracil, and their nucleosides were not absorbed under the experimental conditions. Author

N68-33946 Pennsylvania Univ., Philadelphia.
A MEASUREMENT OF THE RELATIVE DISTRIBUTION OF ENERGY ON A SOLID SURFACE
Joseph Michael Morabito, Jr. (Ph.D. Thesis) 1967 286 p
Available from Univ. Microfilms: HC $13.05/Microfilm $3.70 Order No. 67-12786

A method based on the earlier work of Girifalco was developed by which the distribution of surface energies with respect to the average surface energy [$\bar{\epsilon}_s$ (0)] could be obtained by physical adsorption measurements. The necessary equations are derived, and the assumptions upon which they rest are also carefully analyzed. The adsorption measurements were performed in a volumetric apparatus. The heat of adsorption was calculated from adsorption isotherms (moles adsorbed versus pressure at constant T) at two temperatures (77.5°K and 90.2°K) by use of an equation of Clausius–Clapeyron type. Dissert. Abstr.

N68-33952 Missouri Univ., Rolla.
A STRUCTURAL INVESTIGATION OF BISMUTH FERRATE AND THE $BiFeO_3$ $PbZrO_3$ $PbTiO_3$ TERNARY SYSTEM
Gary David Achenbach (Ph.D. Thesis) 1967 187 p
Available from Univ. Microfilms: HC $8.60/Microfilm $3.00 Order No. 67-12018

Solid state reaction of Bi_2O_3 · Fe_2O_3 mixtures was shown to yield impure bismuth ferrate, $BiFeO_3$, containing $Bi_2Fe_4O_9$ and residual Bi_2O_3; this places the results of much of the literature based on $BiFeO_3$ prepared by this technique in suspect. Single phase polycrystalline $BiFeO_3$ was prepared by multiple nitric acid leaching of sintered samples which contained excess Bi_2O_3 to prevent the formation of $Bi_2Fe_4O_9$ during sintering. X-ray and neutron powder diffraction data indicate that $BiFeO_3$ possesses superstructure, probably resulting from a puckering of the oxygen octahedra. A rhombohedrally distorted unit cell containing two ABO_3 formula units generates all superstructure peaks but a final atomic model could not be developed by trial and error methods. Dissert. Abstr.

N68-33956 Ohio State Univ., Columbus.
SURFACE STUDIES IN THE VAPOR-SOLID SYSTEM BORON TRIIODIDE-TUNGSTEN
Paul Darrell Ownby (Ph.D. Thesis) 1967 165 p
Available from Univ. Microfilms: HC $7.60/Microfilm $3.00 Order No. 67-16325

Adsorption and nucleation of boron triiodide on tungsten by physical vapor deposition and of boron from boron triiodide on tungsten by chemical vapor deposition were studied. The investigation included the determination of some of the properties of boron triiodide which are needed for heterogeneous-nucleation studies. The physical vapor deposition of BI_3 on macroscopic tungsten substrate was studied using a Volmer-type apparatus. The modified Pound treatment of the data was used. The nucleation of BI_3 on tungsten was found to be preceded by multilayer adsorption. The critical concentration of adsorbed monomers required for nucleation was 1.0×10^{15} molecules/cm^2. Adsorption was found to be time dependent at low temperatures. A steady state between impingent and desorption fluxes was found to occur at temperatures of $\lesssim$ 160 K. The nucleation data were described, using a disk model for the critical nucleus. Dissert. Abstr.

N68-34000# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
PHYSICAL PROPERTIES OF SOME PLUTONIUM CERAMIC COMPOUNDS: A DATA MANUAL

B. J. Seddon comp. 1968 68 p refs
(TRG-1601/R/) CFSTI: HC $3.00/MF $0.65

A compilation is presented of the best available data on the physical properties of some of the plutonium compounds which are, or may be, of interest as fuel materials. These are the dioxide, monocarbide, mononitride, monosulphide, and monophosphide of plutonium, uranium–plutonium dioxide, uranium–plutonium monocarbide, uranium–plutonium mononitride, and the plutonium silicides. Author

N68-34003# Japan Atomic Energy Research Inst., Tokyo.
A STUDY ON RADIATION CATALYTIC CHEMISTRY. IRRADIATION EFFECTS ON ACTIVE CARBON CATALYSTS
Shoichi Sato 1968 39 p refs In JAPANESE; ENGLISH summary
(JAERI-1155) CFSTI: HC $3.00/MF $0.65

The application of radiation energy has been developed gradually in many fields. In order to use the energy of radiation more efficiently, the need has arisen for further study of the catalytic processes. Part 1 and 2 deal with the effect of radiation on materials, especially solids, and also with the effect of radiation in phenomena relating to catalysis. In part 3 and 4, the kinetic studies of catalytic phosgene synthesis over active carbons and of the effect of gamma radiation on the kinetic constants are described. The compensation effect in kinetic factors appeared on irradiation and a marked change in catalytic activity was observed with the dose of 10^6R. The catalysts were examined by elementary analysis, ESR absorption and IR spectroscopy, and the results are considered on the basis of the catalytic effects. The catalytic sites are reasonably related to the 2-dimensional structure of carbons, and carbons with highly grown network structure are thought to have high sensitivity to radiation. Author

N68-34022*# Battelle Memorial Inst., Columbus, Ohio.
CHEMICAL VAPOR DEPOSITION OF CHROMIUM ON ThO_2 Final Report
Neil D. Veigel, J. L. McCall, K. E. Meiners, and J. M. Blocher, Jr. 30 Jun. 1968 92 p
(Contract NAS3-10492)
(NASA-CR-72404) CFSTI: HC $3.00/MF $0.65 CSCL 07B

A process was developed to prepare small (5 to 16-gram) quantities of high-purity chromium-ThO_2 powder by deposition of chromium on and/or in the presence of entrained particles of ThO_2. To obtain high-purity chromium, the hydrogen reduction of CrI_2 was used as the coating reaction. On consolidation of the vapor-formed product by hot isostatic pressing, a fair dispersion of ThO_2 was obtained which appears to be stable at 2600 F (1700 K) for 100 hours, as evidenced by the fact that coalescence was limited to local modification of the ThO_2 agglomerates present in the as-pressed condition. Migration of individual ThO_2 particles or agglomerates did not occur. However, both agglomerates and individual particles were spheroidized on heat treatment at 2600 F (1700 K). Author

N68-34029 Minnesota Univ., Duluth.
THE NUCLEATION AND PRECIPITATION OF LITHIUM IN SILICON
John Walter Ferman (Ph.D. Thesis) 1967 120 p refs
Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-14606

A study of lithium precipitation in low oxygen content, monocrystalline silicon was conducted to learn the role of initial lithium concentration, precipitation temperature, pre-annealing temperature, and gamma ray irradiation (Co^{60}) upon the kinetics of precipitation. The purpose was to augment prior knowledge about the phenomena and to gain a better understanding of nucleation. Silicon wafers were lithium saturated by diffusion at temperatures spanning 600°–730°C. Precipitation at temperatures of 94°–157°C was followed by a potentiometric technique. In some cases, pre-annealing at temperatures spanning 800°–1300°C preceded lithium saturation. Gamma ray (Co^{60}) irradiation was conducted at room temperature. Visual and infrared transmission microscopy were employed to determine precipitate particle distribution, shape, and number density. The change in lithium content, calculated from electrical resistivity, with time was analysed in light of diffusion-limited precipitation theory. Dissert. Abstr.

N68-34105# Argentina. Comision Nacional de Energia Atomica, Buenos Aires.
PREPARATION OF I-131 MONOIODOTYROSINE AND I-131 DIIODOTYROSINE WITH HIGH SPECIFIC ACTIVITY AND THEIR SEPARATION BY THIN LAYER CHROMATOGRAFY [PREPARATION DE I-131 MONOYODOTIROSINA Y I-131 DIYODOTIROSINA CON ALTA ACTIVIDAD ESPECIFICA Y SU SEPARACION POR CROMATOGRAFIA EN CAPA DELGADA]
Aldo E. A. Mitta and Gladi B. de Salas 1968 7 p refs In SPANISH; ENGLISH summary Presented at 1st Latin Am. Congr. on Biol. and Nucl. Med., Peru, 1966
(CNEA-235) CFSTI: HC $3.00/MF $0.65

A practical approach for the labelling with radioiodine obtaining high specific activity is proposed. The ^{131}I monoiodotyrosine and ^{131}I diiodotyrosine were obtained, and isolated using thin layer chromatographic techniques which were faster and gave better resolution than those obtained by paper chromatography. The labelled compounds were detected by autoradiography, eluted without significative loss, and then sterilized for biological studies. The influence of labelling time and tyrosine concentration in the ^{131}I [MIT] ^{131}I [DIT] ratio was also studied. Author

N68-34106# Argentina. Comision Nacional de Energia Atomica, Buenos Aires.
PREPARATION OF ACID 3,5 DIPROPIONAMINO 2,4,6 BENZOIC TRIIODO I-131 [PREPARACION DEL ACIDO 3,5-DIPROPIONILAMINO 2,4,6 TRIYODO BENZOICO I-131]
Aldo E. A. Mitta, Leopoldo L. Camin, and Hector Huala 1968 11 p refs In SPANISH; ENGLISH summary
(CNEA-228) CFSTI: HC $3.00/MF $0.65

A method is discussed for the labelling of Diprocon by interchange between ^{131}I and inactive Diprocon, obtaining a radiochemical yield over 95% in only five minutes. The effect of pH, temperature, and molar relation between the reactants on the radiochemical yield is determined as well as the maximum sterilization time and the optical storage conditions for the labelled molecule. Author

N68-34143 Kansas State Univ., Manhattan.
AN EXPERIMENTAL STUDY OF MOLECULAR DIFFUSION IN LIQUIDS
Frederick Sanford Jerome (Ph.D. Thesis) 1967 243 p
Available from Univ. Microfilms: HC $11.05/Microfilm $3.15 Order No. 67-13951

Binary diffusivities of four systems, ethylene glycol-water, triethylene glycol-water, propyle glycol-water and dipropylene glycol-water were experimentally measured at 25°C. Viscosities, densities, and refractivities were also determined for these systems. All data covered the complete range of concentration. A continuous gas laser was the light source in the micro-interferometric diffusion technique employed. The coherent and monochromatic light produced by the laser was found to be very suitable for this interferometric method. The apparatus and data reduction procedures evolved during this study satisfactorily combine accuracy and relative ease of operation. The measured diffusivities were found not to be a linear function of the concentration expressed in mole fraction in any of the four systems studied. Rather, the data exhibit

a negative departure from the straight line joining the extremities of the diffusivity-concentration curve for each system. Dissert. Abstr.

N68-34183 Northwestern Univ., Evanston, Ill.
A PULSE RADIOLYSIS STUDY OF SOME TRANSITION METAL COMPLEXES
William Lee Waltz (Ph.D. Thesis) 1967 206 p
Available from Univ. Microfilms: HC $9.45/Microfilms $3.00 Order No. 67-15360

The reactivity of the hydrated electron, e^-_{aq}, towards some transition metal complexes was investigated by the technique of pulse radiolysis. The complexes studied included those in which the metal is a member of the 2nd and 3rd row transition metals, in addition to some cobalt(III) complexes. The decay of e^-_{aq} was followed spectrophotometrically at 690 mμ after irradiation of aqueous methanol solutions by a microsecond pulse of high energy electrons. The rate of electron decay was found to be first order with respect to both concentration of e^-_{aq} and that of the complex. In general the second order rate constants are of the order expected for diffusion-controlled reactions. For the hexaammine complexes of the cobalt(III) series and for $M(Et_4dien)Cl^+$ where M is Pd(II) or Pt(II), the order of reactivity towards e^-_{aq} can be correlated roughly with the loss in crystal field stabilization energy of the complex upon reaction with e^-_{aq}. Dissert. Abstr.

N68-34195# Argentina. Comision Nacional de Energia Atomica, Buenos Aires.
PREPARATION OF U.F. LIPIODOL WITH I-131 [PREPARATION DE LIPIODOL U.F. I-131]
H. Albani and A. E. A. Mitta 1968 5 p refs In SPANISH; ENGLISH summary Presented at 2d Interam. Conf. on Radio Chem., Mex., 1968
(CENA-236) CFSTI: HC $3.00/MF $0.65

The labelling of U.F. lipiodol with ^{131}I was studied obtaining a radiochemical yield of 100% in only 30 minutes. Author

N68-34251 Indiana Univ., Bloomington.
ALUMINUM ALKOXIDES
David Charles Kleinschmidt 1967 134 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-15120

Using a combination of cryscopic molecular weight determinations and proton magnetic resonance, the proton magnetic resonance spectra of dimeric and trimeric aluminum isopropoxide were identified. At low temperatures the spectrum of a mixture of dimeric and trimeric aluminum isopropoxide and neopentoxide consisted of three sets of partially resolved peaks. Two sets corresponded to the bridging and non-bridging alkoxy groups of the trimer; the third set corresponded to rapidly exchanging dimer. Accurate integration by curve analysis was consistent with a ration of 4:5 rather than 1:2 for the peaks corresponding to bridging and non-bridging alkoxy groups, respectively. This integration supports a novel trimeric structure, which contains two four-membered rings and a five-coordinated aluminum, rather that the accepted monocyclic structure for the trimer. Author

N68-34252 Northwestern Univ., Evanston, Ill.
CYANIDE BRIDGE COMPOUNDS WITH THE GROUP FOUR METAL TETRAFLUORIDES
John Jay Rupp (Ph.D. Thesis) 1967 127 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00

A number of addition compounds have been formed between the group IV metal tetrafluorides, SiF_4, GeF_4, and SnF_4, and dicyanobis(1,10-phenanthroline)iron(II), $Fe(phen)_2(CN)_2$, and the 4,7-diphenyl-1,10-phenanthroline analog, $Fe(phenO_2)_2(CN)_2$. Three general types of adducts were found with 1:1, 2:1, and 3:1 mole ratios of acceptor to donor. The 1:1 complexes are cyclic dimers in both coordinating and noncoordinating solvents as indicated by molecular weight and infrared data. The 2:1 complexes are monomeric in a coordinating solvent and dimeric in a noncoordinating solvent as indicated by molecular weight data for $Fe(phenO_2)_2(CN)_2 \cdot 2GeF_4$. The dimer is believed to be held together by means of fluorine bridges giving the group IV atom a coordination number of six. The complex $Fe(phen)_2(CN)_2 \cdot 3GeF_4$ is stable at low temperatures, but above −30 it undergoes a reversible decomposition to the 2:1 adduct and free germanium tetrafluoride. Dissert. Abstr.

N68-34298*# Cornell Univ., Ithaca, N. Y. Dept. of Applied Physics.
HYDROGEN AND OXYGEN ON A (110) NICKEL SURFACE
J. W. May and L. H. Germer 10 Apr. 1968 36 p refs
(Grant NGR-33-010-029)
(NASA-CR-96786; Rept.-919) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Low energy electron diffraction patterns from a (110) nickel surface that has been exposed to hydrogen at room temperature show a (1×2) surface structure characterized by double spacing normal to the close packed rows of surface atoms. Reasons are given for concluding that the surface is reconstructed into inclined ridges covered with adsorbed hydrogen atoms. When such a surface is exposed to oxygen, also at room temperature, a series of structures is produced which contain more and more oxygen. The presence of hydrogen modifies the first of these, but later in the series they develop just as they would in the absence of hydrogen. When hydrogen is used to remove oxygen, it is found that the efficiency of removal is a strong function of oxygen coverage as well as of crystal temperature, with the efficiency very low for high coverage. Half monolayer coverage is removed by hydrogen with a mean efficiency between 10^{-5} at 400°K and 0.02 at 600°K. Anomalies in the temperature variation of this efficiency in the range above 450°K are associated with the onset of long range surface diffusion of oxygen at this temperature, and also with bulk diffusion to the surface. Author

N68-34310# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
REACTION OF SULFUR DIOXIDE WITH GRAPHITE
R. C. Gilberson and G. L. Tingey 7 Jun. 1968 12 p refs Presented at the Am. Chem. Soc. Meeting, Portland, Ore.
(Contract AT(45-1)-1830)
(BNWL-SA-1849; CONF-680608-5) CFSTI: HC $3.00/MF $0.65

Studies were made on the rate of graphite removal by exposure to small partial pressures of SO_2 carried by a helium gas stream. The effects of added CO and added CO_2 on the weight loss rates were also determined. The primary products in the system $C-SO_2-He$ appeared to be CO and solid S, in the temperature range of 700 to 1400°C. Secondary products COS, CO_2, and CS_2 were observed at high temperatures or when CO was added to the inlet gas. It is suggested that the CO competes with the graphite for the activated SO_2. This process requires a graphite surface to be significant. NSA

N68-34429# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACADEMY OF SCIENCES OF THE USSR. SIBERIAN DIVISION. SPECTROSCOPY METHODS AND APPLICATION (SELECTED ARTICLES)
3 Nov. 1967 14 p refs Transl. into ENGLISH from the publ. "Spektroskopiya. Metodyi i Primeneniye" Moscow, Izd-vo, 1964 p 128–130 and 143–145
(FTD-HT-23-882-67; AD-669275)

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N68-34430# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

OPTICAL STUDY OF FLUORIDES AND OXIDES OF RARE EARTH METALS

S. S. Batsanov, G. N. Grigor'yeva, and L. R. Batsanova *In its* Acad. of Sci. of the USSR. 3 Nov. 1967 p 1–3 refs (See N68-34429 21-08)

Fluorides of the rare earth metals (REM) were obtained by decomposing double salts of the type $nNH_4F\text{-}LnF_3$ at 600°C. The samples were optically isotropic or pseudoisotropic, whereas according to literature data they should have been anisotropic. Infrared spectra before and after high-temperature treatment showed an absorption band at 400–500 cm^{-1} whose intensity decreased after the defects were annealed. Oxides of REM can be prepared by calcining any salt, including the fluorides or oxyfluorides of lanthanides. The refractive indices of oxide samples at 800°C ranged from 1.8 to 2.05. As the temperature rises, the refractive indices increase, and optical anisotropy becomes more pronounced. Absorption peaks at 550–650 cm^{-1} were found. For both fluorides and oxides of REM, the following characteristics were observed: increase in refractive indices and density on heating, appearance of optical anisotropy during the process, and decrease in the intensity of the absorption peak corresponding to an asymmetrial valence vibration of the REM-F and REM-O bonds. These optical properties of REM fluorides and oxides are attributed to the defective crystal structures. Author

N68-34431# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INFRARED ABSORPTION SPECTRA OF SOME SUBSTANCES IN DIFFERENT STATES OF AGGREGATION

A. V. Korshunov, L. S. Solov'yev, and V. S. Korobkov *In its* Acad. of Sci. of the USSR. 3 Nov. 1967 p 4–7 refs (See N68-34439 21-08)

The IR spectra of gaseous, liquid, and crystalline phenol, guaiacol, and biphenyl were obtained; the spectra of the crystals are given also at the temperature of liquid N. The spectra of phenol in different states differed mainly in the region of deformation modes, and the spectra of guaiacol mainly in the region of valence vibrations. The differences were caused by strengthening of the H bonds in going from the gaseous to the crystalline compounds. There was no great difference in the spectra of gaseous and liquid biphenyl, but a sharp change and new lines occurred in the spectrum of the crystalline compounds due to mutual effects of molecular vibrations on lattice vibrations. This effect is apparently weaker in the presence of H bonds. Author

N68-34446# Dow Chemical Co., Golden, Colo. Rocky Flats Div.

MOLE REACTION—FORTRAN-4 DATA REDUCTION PROGRAM FOR GAS-GAS AND GAS-SOLID REACTIONS

Robert W. Loser 21 May 1968 14 p
(Contract AT(29-1)-1106)
(RFP-1107) CFSTI: HC$3.00/MF$0.65

The Mole Reaction—FORTRAN IV program represents a comprehensive evaluation of gas pressure data from gas-gas and gas-solid reactions. The program reduces the pressure, volume, temperature and sample volume, and the composition data to give the rate of change in the concentration of residual gases in a reaction and the total change in moles of each gas for a number of reactions. From the initial reactant and temperature-dependent input data, the reactions are evaluated by gas law equations and the formation or consumption of key gases is presented. Author (NSA)

N68-34452# University of Southern Calif., Los Angeles. Dept. of Chemistry.

SCISSIONS OF SULFUR–HALOGEN AND SULFUR–SULFUR BONDS Final Report, 19 Jan. 1963–1 SEP. 1966

Norman Kharasch Jun. 1968 8 p
(Contract DA-31-124-ARO(D)-68)
(AROD-4040-2-C; AD-672520)

A series of investigations was carried out relating to the synthesis of sulfenyl chlorides, including 3-chloroformylpropane sulfenyl chloride, 2,4-dinitrobenzene sulfenyl chloride (by a much simpler route), and pentachlorobenzene sulfenyl chloride. The utilization of gamma-thiobutyrolactone in the synthesis of the first-mentioned sulfenyl chloride represents a convenient route to this bi-functional sulfenyl chloride. A number of free-radical reactions of sulfenyl chlorides, involving homolytic scission of the sulfur-halogen bond, were also carried out. These reactions open up a wide area of study which appears worth further investigation. Author (TAB)

N68-34467# Western Reserve Univ., Cleveland, Ohio. Electrochemistry Research Lab.

INFRARED INTERNAL REFLECTION STUDIES OF THE GERMANIUM ELECTROLYTE INTERFACE

Ernest Yeager and Allan H. Reed 1 Feb. 168 112 p refs
(Contract Nonr-1439(09))
(TR-4; AD-672190)

Infrared internal reflection spectroscopy has been used to study the germanium electrode interface with the objective of determining the applicability of the method to the study of adsorption from solution and the semiconductor space-charge region. The sensitivity of the present instrumentation was sufficient to detect the C-H stretching frequency of a monolayer of an adsorbed organic molecule with D2O as the solvent but insufficient to follow small changes in surface coverage. The study of the excess carrier concentration in the space charge appears promising using a technique involving the square-wave modulation of the electrode potential with the signal from the thermocouple detector of the infrared spectiometer amplified with a phase sensitive tuned amplifier. The dependence of the spectra so recorded, on wavelength and bias and modulation potentials have been examined for n-type germanium of 1.0 and 10.0 ohm-cm. Experimental results are qualitatively in accord with predictions. Author (TAB)

N68-34479# Atomics International, Canoga Park, Calif.

OXIDATION EXPERIMENTS ON ORGANIC REACTOR COOLANT

O. R. Stahl and G. T. Tiedeman 22 Apr. 1968 82 p refs
(AI-AEC-MEMO-12688) CFSTI: HC$3.00/MF$0.65

Commercial Santowax OM was oxidized with an oxygen–argon gas mixture. The Santowax OM was circulated around a loop countercurrent to the gas mixture bubbling up through the coolant in a reaction vessel that contained 90% of the liquid. The oxidation was studied at various temperatures (350 to 620°F), oxygen concentrations (1 to 4% O_2 in Ar), gas flow rates (0.15 to 0.66 moles/min), and pump rates (9 to 29 gph). The effluent gas stream was monitored continuously for oxygen and carbon dioxide content. The gas stream was also sampled periodically for off line analysis by mass spectrometry. Coolant samples taken during the experiments were analyzed for the oxygen containing compounds. The oxidation rate of freshly distilled Santowax OM at high temperature ($\geq$ 580°F) initially increased rapidly to a maximum then slowly decreased by a factor of 3 to 5 to a steady-state oxygen consumption rate

(about 20 to 25% of the oxygen being consumed). Nonterphenyl impurities present in the distilled Santowax OM caused the peaking in the oxidation rate and also resulted in a ten-fold higher steady-state oxygen uptake rate. The activation energy for the oxidation of Santowax OM was calculated at 13 ± 3 kcal/mole. The production rate of oxygenated compounds including the gaseous products and bound oxygen compounds in the coolant, appeared to follow the oxygen consumption rate; thus at high temperatures the production rates rapidly increased then slowly decreased to a steady-state rate. At high temperatures a film containing about 4% oxygen was formed in the reaction vessel but not during the low-temperature oxidations. The data also indicated that under the conditions studied the oxygen consumption rate had a first order dependence on oxygen concentration, decreased with increased gas flow and decreased with decrease in pump rate. An irradiation dose of ≈3 × 10^6 rad/hr had no significant effect on the oxidation rate. Author (NSA)

N68-34503# Case Western Reserve Univ., Cleveland, Ohio. Electrochemistry Research Lab.
HYDROGEN OVERPOTENTIAL ON PLATINUM
Frank A. Ludwig and Ernest Yeager 1 Feb. 1968 276 p refs
(Contract N00014-67-C-0389)
(TR-21; AD-672360)

Hydrogen electrode kinetics have been examined in Pt in HCl solutions over a large range of anodic and cathodic current densities using several techniques (rotating disc-ring, cyclic linear sweep voltammetry, interrupter, and pulse techniques). Bubble formation was studied on the rotating disc electrode photographically. The experimental results support the following conclusions: (1) Under most anodic and cathodic conditions in concentrated acids, the hydrogen electrode on Pt is under combined H2-diffusion and kinetic control. (2) Both the discharge and oxidation of H2 on Pt proceed through the combination mechanism with the atomic-combination step rate controlling. Two types of absorbed hydrogen appear to be involved--one strong at high coverage and one weak at lower coverage. Thus: M- + H(+) + e(-) = M-HA; MHA = M-HB; 2M-HB = M- + H2 where M-HA is the more strongly bound hydrogen. (3) In well purified solutions, extreme supersaturation with dissolved H2 occurs during cathodic polarization at high currents densities. (4) Theoretical considerations reveal that the transfer coefficient or its equivalent for the recombination and ion-plus-atom steps are probably closer to unity than the usual value of 1/2. Author (TAB)

N68-34504# Army Materials and Mechanics Research Center, Watertown, Mass.
ON THE KINETICS OF PRECIPITATE DISSOLUTION
Howard B. Aaron Jun. 1968 11 p refs
(AMMRC-TR-68-14; AD-672482)

Model for the dissolution of a precipitate which is initially in equilibrium with its depleted matrix shows that (a) earlier works by Thomas and Whelan is probably incorrect and (b) diesolution may be used to obtain values of D. Author (TAB)

N68-34506# Case Western Reserve Univ., Cleveland, Ohio. Ultrasonics Research Lab.
ULTRASONIC STUDIES OF DIFFUSION CONTROLLED IONIC ASSOCIATION-DISSOCIATION
Louis Goldfarb and Ernest Yeager Jan. 1968 95 p refs
(Contract Nonr-1439(04))
(TR-32; AD-672359)

Ultrasonic absorption measurements have been made in solutions of copper sulfate, magnesium sulfate, and cobalt sulfate over the frequency range 45 to 550 MHz using pulse modulated waves and a send-receive technique. The excess relaxational absorption data were computer processed and the relaxation times calculated. These results indicate that the high frequency relaxation for di-divalent electrolytes occurs at substantially higher frequencies than reported by earlier workers and is concentration dependent. On the basis of the values for partial molal volume changes, energies of activation, concentration dependence, deuteration effects, and foreign electrolyte effects, the high frequency absorption peak has been attributed to the diffusion controlled second order process leading to the formation of an encounter complex. The report also discusses possible difficulties arising from the lack of data for the non-relaxing portion of the absorption with the ionic constituents present. Author (TAB)

N68-34510# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
EXPERIMENTS ON CHEMISTRY OF ELEMENT 104: KURCHATOVIUM. 2. CHEMICAL INVESTIGATIONS OF A SPONTANEOUSLY FISSIONING ISOTOPE OF 0.3 SEC HALF-LIFE [OPYTY PO KHIMII ELEMENTA 104-KURCHATOVIYA. 2. KHIMICHESKOE ISSLEDOVANIE SPONTANNO DELYASHCHEGOSYA IZOTOPA S PERIODOM POLURASPADA 0.3 SEKUNDY]
I. Zvara, Yu. T. Chuburkov, R. Tsaletka, and M. P. Shalaevskii 1968 26 p refs In RUSSIAN
(JINR-P7-3783)

For the purpose of chemical identification and investigation of a spontaneously fissioning nuclide of 0.3 sec half-life (obtained in 1964 at Dubna and identified by the nuclear method as Element 104 isotope) the absorption of molecules of its chloride from the gas phase on solid surfaces was compared with that of chlorides of known elements. The chloride is adsorbed approximately in the same way as chloride of Hf, but more than niobium chloride and considerably less than the chlorides of In, Th, Cm, Cf, Fm, and of Element 102. The heat of vaporation of the chloride of Element 104 was estimated to be 16 to 23 kcal/mole. Total of nuclear and chemical data shows that the isotope investigated belongs to the element of the Periodic Table with the atomic number 104, which is close in properties to Hf and must be in subgroup IV B. Author (NSA)

N68-34574# Harvard Coll. Observatory, Cambridge, Mass.
SHOCK-TUBE SPECTROSCOPY IN THE ULTRAVIOLET Final Report
W. H. Parkinson and E. M. Reeves Jul. 1968 10 p refs
(Contract Nonr-1866(48))
(AD-672224)

A summary is given of the results of a research program which employed aerodynamic shock tubes for the study of a large number of atoms and molecules in the wavelength range extending from 600A to the visible. A list of publications resulting from the work is included. TAB

N68-34614# Oak Ridge National Lab., Tenn.
THE CHEMICAL EQUILIBRIA OF FISSION-PRODUCT-NUCLEAR FUEL MIXTURES: THE URANIUM OXYGEN AND THE URANIUM-OXYGEN-STRONTIUM SYSTEM
M. H. Fontana (Ph.D. Thesis—Purdue Univ.) Jul. 1968 272 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2105) CFSTI: HC $3.00/MF $0.65

Methods of using multi-component chemical equilibrium computer techniques were developed for computation of chemical equilibria in the gas phase around a melted fuel element, and they were tested against published Knudsen cell-mass spectrometer data for the U–O system. This served as a base point from which the U–Sr–O system was extended. It was found that for the U–O systems, the gas phase composition could be predicted as a function of the O/U ratio in the solid phase, given the equilibrium constants of formation of the compounds of interest and the experimentally determined total pressure and atom ratios in the gas phase. The U–Sr–O system was estimated by relating the chemical species in the gas phase to a computed equilibrium composition

of the same species in the condensed phase. The pressures of the strontium bearing species were then computed by using estimated Henry's law coefficients. The effect of excess oxygen pressure, variation in activity coefficients, variability in the thermodynamic properties, and changes in O/U (solid) ratios were investigated.
NSA

N68-34615# Oak Ridge National Lab., Tenn.
STUDY OF GAS-EVOLUTION FROM SOL-GEL THORIA AND THORIA-URANIA
J. B. Cordiner and O. C. Dean Jul. 1968 27 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2268) CFSTI: HC $3.00/MF $0.65

This gas-evolution study was designed to determine the sources of gases from sol-gel thoria and to indicate the steps that need to be taken to limit undesirable quantities and species to a minimum. A test program was instituted to check the most significant trends from earlier data and to obtain additional information on these gases. The findings indicated that a number of sources were responsible. Carbon and nitrogen materials in the interior of the calcined oxide are the main source of carbon monoxide, carbon dioxide, and nitrogen in the evolved gases, and their contents should be kept to the economic minimum in the unfired sol-gel. Nonstoichiometric oxygen in the calcinated oxide is responsible for free oxygen but may be kept to a minimum by use of a reducing calcining atmosphere such as 4% hydrogen-argon. Water vapor and carbon dioxide are readily absorbed on the surface of the pores and are responsible for most of the H_2O and part of the CO_2.
Author (NSA)

N68-34643*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
OXYGEN RECLAMATION FROM CARBON DIOXIDE USING A SOLID OXIDE ELECTROLYTE
Joseph Weissbart, Wilson Smart, and Theodore Wydeven May 1968 2 p refs Presented at the 39th Ann. Sci. Meeting of the Aerospace Med. Assoc., Bal Habour, Fla., 6-8 May, 1968
(NASA-TM-X-61194) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Fabrication and operational performance of CO_2 electrolyzers using disk shaped solid electrolytes are discussed. Life tests were conducted at 850°C at current efficiencies approaching 100%, using a gold metal seal and a magnesium aluminum glass-ceramic seal. Performance results are tabulated. Design parameters for a one-man prototype electrolyzer for reclaiming oxygen from expired CO_2 during prolonged space missions are estimated. They are: operating temperature, 850°C; current density, 100 mA/cm^2; O_2 Faradaic efficiency, ≈ 100%; and electrolysis power efficiency ≈ 50%.
B.P.

N68-34645# Naval Research Lab., Washington, D. C.
ANODIC OXIDATION OF HYDROGEN ON IRON AND PLATINUM IN SODIUM HYDROXIDE SOLUTION Interim Report
Sigmund Schuldiner and Clarence M. Shepherd 24 May 1968 11 p refs
(NRL-6718; AD-672314)

In a rigorously controlled high-purity closed system, the electrochemical behavior of Fe and Pt electrodes for the hydrogen oxidation reaction showed marked differences in both the active and passive regions. The catalytic behavior of the two metals reflects the differences in metallic properties and anion adsorption. Iron was found to be a far better catalyst with a much less pronounced passive region. Iron corrosion was insignificant. Small amounts of platinum on iron strongly retarded hydrogen oxidation. Significant Pt dissolution and deposition on the iron working electrode was not found.
Author (TAB)

N68-34653# Los Alamos Scientific Lab., N. Mex.
ON THE ACCUMULTAION OF He-H MOLECULAR COMPLEXES
P. T. Sikora, David Depatie, and A. F. Schuch 24 Jun. 1968 2 p refs
(Contract W-7405-eng-36)
(LA-3956-MS) CFSTI: HC $3.00/MF $0.65

Liquid tritium is proposed as an agent for producing and stabilizing macroscopic quantities of He-H molecular complexes. Information on their existence could be inferred from simple pressure measurements.
Author (NSA)

N68-34670# Sandia Corp., Albuquerque, N. Mex. Aerospace Sciences Div.
FLASH PHOTOLYZED REACTIONS MONITORED BY TIME-OF-FLIGHT MASS SPECTROMETRY
R. T. Meyer Apr. 1968 20 p refs Presented as Paper No. 55, "Symp. on Applications of Mass Spectrometry to Gas Phase Reactions", 155th Natl. Meeting, Am. Chem. Soc., San Francisco, 4 Apr. 1968
(SC-RR-68-162; CONF-680308-11) CFSTI: HC $3.00/MF $0.65

The techniques of flash photolysis and time-resolved mass spectrometry were combined for the study of fast gas phase reactions. The apparatus provides an incident ultraviolet light flux of 1.0×10^{18} quanta per cm^2 per flash and a spectrometer sensitivity of 5×10^{-8} mole per liter. Time resolution is 1.4 μsec at successive 50 μsec intervals. The following chemical systems were investigated: nitrogen dioxide sensitized reaction between hydrogen and oxygen; decomposition of nitromethane; termolecular recombination of iodine atoms in the presence of nitric oxide; and reaction of excited iodine ($^2P_{1/2}$) atoms with methyl iodide.
Author (NSA)

N68-34705# National Bureau of Standards, Washington, D. C.
TABLES OF MOLECULAR VIBRATIONAL FREQUENCIES, PART 3
Takehiko Shimanouchi (Tokyo Univ.) Mar. 1968 46 p refs
(NSRDS-NBS-17, Pt. 3) GPO: $0.30

This report contains fundamental vibrational frequencies of 54 molecules together with vibrational assignments, sources of data, brief comments, and citations of references. The fundamental frequencies are obtained mainly from the infrared and Raman spectra. When these are not available, other experimental data such as microwave results are taken into account. The selection of vibrational fundamentals from observed data is based upon careful studies of the spectral data and comprehensive mathematical analyses. The tables were designed to provide a concise summary needed for the computation of ideal gas thermodynamic properties.
Author (USGRDR)

N68-34706# National Bureau of Standards, Washington, D. C. Inst. of Basic Standards.
OSCILLATOR STRENGTHS AND TRANSITION PROBABILITIES FOR 3288 LINES OF Fe 1
C. H. Corliss and J. L. Tech Mar. 1968 72 p refs
(NBS-MONO-108) GPO: $0.45

A homogeneous set of intensity-related data has been calculated for 3288 spectral lines of Fe (1) in the region from 2100 to 9900 angstroms. The data are presented on the absolute scale established in a previous work by Corliss and Bozman. In that work and the later extensions of it by Corliss and Warner, the calculation of gf-values included the application of an empirically determined normalization correction to the level populations, the normalization being given as a function of upper energy level for the transition. Since recent investigations do not support these excitations corrections in the case of Fe (1) and certain other spectra, the present tabulation incorporates a removal of that normalization function.
USGRDR

N68-34722# RAND Corp., Santa Monica, Calif.
ATMOSPHERIC OZONE: AN ANALYTICAL MODEL FOR PHOTOCHEMISTRY IN THE PRESENCE OF WATER VAPOR
C. B. Leovy Jun. 1968 34 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5643-PR; AD-672253)

A presentation of an approximate analytic model of ozone photochemistry, including reactions with hydrogen compounds, for the atmospheric region between 15 and 60 km. The model is used to study time-dependent processes, sensitivity of the equilibrium-concentration values to uncertainties in reaction rates, and variations in the equilibrium ozone concentration with latitude and season. The reaction scheme used is a simplified version of one used previously by B. G. Hunt. Approximate equilibrium relations are derived and are then used to obtain simplified equations to describe the behavior of a complete system. Intended to clarify the roles of various possible reaction schemes for ozone, the study should be of interest to those concerned with meteorological problems in this portion of the atmosphere and to those concerned with laboratory investigation of the chemistry of oxygen/hydrogen systems. Author (TAB)

N68-34724# National Bureau of Standards, Washington, D. C. Inst. for Basic Standards.
SELECTED VALUES OF CHEMICAL THERMODYNAMIC PROPERTIES: TABLES FOR THE FIRST THIRTY-FOUR ELEMENTS IN THE STANDARD ORDER OF ARRANGEMENT
D. D. Wagman, W. H. Evans, V. B. Parker, I. Halow, and S. M. Baily Jan. 1968 267 p ref
(NBS-TN-270) GPO: $1.25

Tabulations are given of the values, where known, of the enthalpy of formation, Gibbs energy of formation, enthalpy, entropy (298.15K), heat capacity (298.15K), and enthalpy of formation (zero deg. K) of the following elements, and certain of their inorganic, organic, and metalorganic compounds: O, H, He, Ne, Ar, Kr, Xe, Rn, F, Cl, Br, I, At, S, Se, Te, Po, N, P, As, Sb, Bi, C, Si, Ge, Sn, Pb, B, Al, Ga, In, Tl, Zn, Cd. USGRDR

N68-34746# Babcock and Wilcox Co., Lynchburg, Va. Nuclear Development Center.
GEL-ADDITION PROCESS CHEMICAL STUDIES Quarterly Progress Report, Nov. 1967–Jan. 1968
R. N. Gurley, comp. May 1968 52 p refs
(Contract AT(30-1)-3714)
(BAW-3714-6; QPR-6) CFSTI: HC $3.00/MF $0.65

Development of the Gel-Addition process for preparing mixed plutonia-urania fuels has continued. In addition, the overall program was extended to include the development of a pilot plant for the industrial production of $(U,Pu)O_2$ particulate fuel using the ORNL mixed-sol approach. This task also includes sol and gel preparation studies. Emphasis was placed on a statistically controlled plutonium addition experiment, improving analytical methods, irradiation testing of a calibration capsule (UO_2–20 wt % PuO_2 fuel), and single and mixed sol studies. Notable success was achieved in each of these areas. Plutonium pickup mechanisms were hypothesized. Controlled-potential coulometric analysis of Pu(VI) in plutonium solutions was developed and adopted for regular laboratory use. The fabrication of capsules for use in inpile restructuring studies was started, since the results of a calibration capsule experiment confirmed the validity of the associated nuclear and thermal design parameters. Uranium dioxide sols and spheres can now be produced routinely using laboratory and pilot plant equipment. Author (NSA)

N68-34763*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
QUALITATIVE ANALYSIS OF GAS MIXTURES BY MICROWAVE SPECTROSCOPY
William F. White [1968] 39 p refs Presented at the 155th Natl. Meeting of the Am. Chem. Soc., San Francisco, 31 Mar.–5 Apr. 1968
(NASA-TM-X-61220) CFSTI: HC $3.00/MF $0.65 CSCL 07D

An overview is presented of the characteristics and capabilities of microwave spectroscopy as an analytical tool in identifying the components of gas and vapor mixtures and of measuring the concentrations of each. The choice of frequency range is discussed with respect to the number of molecules which can be detected and the effect of frequency on sensitivity to trace gases. The frequency range needed is determined by the distribution of absorption lines throughout the microwave range which is, in turn, a function of molecular structure. The effects of sample pressure can scan rate are assessed, and absorption parameters are defined. Figures are included to illustrate the effects of pressure on resolution. The type of ambiguity which may occur in a mixture is depicted to emphasize the necessity of having available for reference the entire spectrum of every molecule. A possible approach to the analysis of an unknown sample is suggested. Development work on an automated spectrometer and a real-time data analysis program is reviewed, along with the studies being conducted on the use of double resonance modulation as a means of simplifying the observed spectrum. M.G.J.

N68-34766# Consejo Superior de Investigaciones Ce Cientificas, Barcelona (Spain). Departamento de Quimica Organica.
SYNTHESIS AND PROPERTIES OF ALKAROMATIC CHLORACARBONS Final Scientific Report, 1 Nov. 1963–31 Dec. 1967
Manuel Ballester, Juan Castaner, and Juan Riera Jan. 1968 100 p refs
(Contract AF 61(052)-749)
(ARL-68-0107; AD-672319)

The study of the alkaromatic chlorocarbons initiated some years ago was continued. New syntheses of highly strained, overcrowded chlorocarbons were performed. In total, fifteen new reactions were found. A new class of substances was discovered: the Inert Free Radicals. Also, stable alpha-chlorocarbanion salts and other chlorinated carbanions were prepared for the first time. A total of seventy-three new highly chlorinated and perchlorinated substances is reported, including twelve carbon free radicals. Author (TAB)

N68-34807 Bureau of Mines, Boulder City, Nev.
PREPARATION OF ANHYDROUS CHROMOUS CHLORIDE
Robert L. de Beauchamp and Thomas A. Sullivan Oct. 1968 10 p refs
(BM-RI-7194)

The design a chlorination apparatus to prepare $CrCl_2$ free of $CrCl_3$ by the direct reaction of chlorine and chromium is given. Equipment and procedures were developed for routine preparation of 25-pound batch quantities of anhydrous $CrCl_2$. Calcium, iron, nickel, and silicon impurities were in the 0.01 to 0.05 percent range, and all other impurities were below 0.01 percent. Author

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N68-33653 Lehigh Univ., Bethlehem, Pa.
A BINARY CHANNEL CHARACTERIZATION USING PARTITIONED MARKOV CHAINS WITH APPLICATIONS TO ERROR CORRECTING CODES

Bruce Dale Fritchman (Ph.D. Thesis) 1967 132 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-14934

The problem of characterizing binary error statistics, as found on real communication channels, is studied. Functions of finite state Markov chains are proposed as error models, and are investigated both analytically and experimentally in order to determine their suitability as channel models. Two distributions, which are relevant to code evaluation as well as to model specification, are derived, i.e., the error-free run and error-cluster distributions. It is shown that for an N-state model, partitioned into a group of k error-free states and N-k error states, that the error-free run distribution can be represented as the weighted sum of k exponentials, and the error-cluster distribution as the weighted sum of N-k exponentials. As evidence of the capability of such models to characterize real digital communication channels, a simple class of models is investigated and shown experimentally to be capable of representing HF radio statistics. Dissert. Abstr.

N68-33690 Illinois Univ., Urbana.
RELATIONSHIPS BETWEEN CONTINUOUSLY SCALED, PERIODIC AND LOG PERIODIC STRUCTURES WITH APPLICATIONS TO LOG PERIODIC ANTENNAS
Kenneth Earl Jones (Ph.D. Thesis) 1967 170 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-11871

This report describes the results of several studies on network models of log-periodic structures. The equations for a continuously scaled structure are written in terms of the product ωx, where ω is the radian frequency and x is the point of observation, so that the voltage and current are independent of frequency, provided the position of observation is changed in such a way that the product ωx remains constant. It is shown that this model predicts the input impedance as a function of position along the line. In particular it is shown that the model predicts the observed input impedance behavior when the frequency is approaching the high frequency limit of the antenna. The numerical computations for the voltage and current distribution compare favorably with measured data. The phase velocity on the transmission line model in the active region and at the input region is also found to agree with experimentation. Dissert. Abstr.

N68-33711 IIT Research Inst., Chicago, Ill.
FORCE-REFLECTING SERVOMECHANISMS WITH SIGNAL TRANSMISSION TIME DELAY
William Michael Thompson (Ph.D. Thesis) 1967 198 p
Available from Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 67-12580

In this dissertation the absolute and relative stability of a force-reflection servomechanism with time delay in the signal transmission channels is investigated by several methods. One method employs a less well-known stability criterion for time lag systems due to Pontryagin. The criterion is adapted and extended for use in this study. The servomechanism is the type that provides the connecting links in currently-used, electrically-connected, master-slave manipulators. The time delay is due to the time required for signals to traverse the distance between the master and slave arms, if they are separated by large distances. Two time delays of approximately four and twenty-three milliseconds are used to illustrate the Pontryagin method. The latter delay corresponds to a separation distance of about four thousand miles. Dissert. Abstr.

N68-33712 Pennsylvania Univ., Philadelphia.
SCATTERING OF A DIPOLE FIELD BY FINITELY CONDUCTING CIRCULAR CYLINDERS
Gerasimos Nicholas Tsandoulas (Ph.D. Thesis) 1967 119 p
Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-12812

In this dissertation the problem of scattering of an axial dipole field by an infinite circular cylinder is considered. No restrictions, other than homogeneity and isotropy, are placed on the properties of the material comprising the obstacle. The solution is arrived at in the following manner. The differential equation approach is adopted and the fields, inside the cylinder as well as outside, are expanded in appropriate functions peculiar to the cylindrical geometry. Matching tangential components at the boundary yields the expansion coefficients, thus completing the formal solution. In the next step, an asymptotic expansion valid in the far field region is sought for the integral expression for the diffracted field. All the integrals involved in the solutions are actually Fourier transforms over a continuous eigenvalue spectrum arising from the infinite axial extent of the obstacle. Dissert. Abstr.

N68-33781 Polytechnic Inst. of Brooklyn, N. Y.
TERNARY CODES FOR REGENERATIVE DIGITAL TRANSMISSION SYSTEMS
Richard Homer McCullogh (Ph.D. Thesis) 1967 191 p
Available from Univ. Microfilms: HC $8.80/Microfilm $3.00 Order No. 67-13407

Codes for a large class of practical digital transmission systems are discussed. These systems utilize regenerators whose error performance depends on the transmitted signal. Whereas many codes are designed to detect or correct errors that have occurred, the codes considered here are designed to prevent errors from occurring. An introductory chapter discusses digital communication systems. Attention is focused on the regenerator, which derives its timing from the transmitted signal. Requirements are defined for codes which will reduce the errors caused by intersymbol interference due to suppression of the low frequency components of the signal (Restricted Sum Codes) and codes which will reduce the errors caused by timing jitter due to fluctuation of the amplitude of the timing wave (Restricted Amplitude Codes). A practical error model for the ternary regenerative channel is developed. Three general classes of nonlinear codes are given for the ternary regenerative channel: (1) Restricted Sum Codes which are designed to reduce errors caused by intersymbol interference; (2) Restricted Amplitude Codes designed to reduce errors caused by timing jitter; (3) Composite Codes which are designed to combat errors caused by intersymbol interference and timing jitter. A ternary code of length four called Quaternary Selected Ternary (QST) is introduced, and is shown to be well suited for the transmission of binary information. Dissert. Abstr.

N68-33843 Iowa State Univ. of Science and Technology, Ames.
VARIANCE OF THE STATE ESTIMATION ERROR OF AN ADAPTIVE KALMAN FILTER
Allan Eugene Baker (Ph.D. Thesis) 1967 69 p
Available from Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 67-12942

The Kalman filter requires the specification of the means and variances of the signal and noise processes in order to estimate the signal process, or state vector. If the noise or measurement error vector is uncorrelated from one sampling instant to the next, and has zero mean but unknown variance, one can still use the framework of the Kalman filter equations, combined with a statistical estimator of the variance, to estimate the signal. The purpose of this study was to investigate the effectiveness of two forms of adaptive filters in adapting to changes in the measurement error covariance matrix. The results of the computer simulations are shown in a series of graphs which display typical estimation-error variances for these situations. It appears from this study that adaptive filters can, in certain cases, be formed which give error variances within 20 per cent or less of the optimal results. Dissert. Abstr.

N68-33967 Polytechnic Inst. of Brooklyn, N. Y.
THE STATISTICAL TRANSIENT BEHAVIOR OF PHASE-LOCKED LOOPS DUE TO ABRUPT CHANGES IN C-W SIGNAL AND NOISE LEVELS
Frank Jackson Scire (Ph.D. Thesis) 1967 216 p
Available from Univ. Microfilms: HC $9.90/Microfilm $3.00 Order No. 67-13420

The statistical transient behavior for both the first and second order phase-locked loop (PLL) is determined when their inputs are subjected to abrupt changes in signal and noise levels. The signal is assumed to be an unmodulated carrier wave, and the noise an essentially-white Gaussian process. The noise is also considered stationary during all time intervals not containing the abrupt level changes. The transients that are considered are the result of the following PLL inputs: (1) $N/S >> 1$ or noise alone, and (2) Comparable levels of signal and noise ($S/N \geq 1$). Dissert. Abstr.

N68-33986 Auburn Univ., Ala.
CIRCULAR ARRAYS OF TANGENTIAL AND RADIAL DIPOLES
John Layman Hilburn (Ph.D. Thesis) 1967 200 p
Available from Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 67-12516

The elements of the circular antenna arrays investigated consist of N identical center-fed cylindrical dipoles whose centers are equally spaced around the circumference of a circle. Two cases are considered for the orientations of these elements. In the first case, designated tangential arrays, the elements are placed tangential to the circle and lie in the plane of the circle. In the second case, designated radial arrays, the elements are placed radial to the circle and also lie in the plane of the circle. Integral equations are derived to define the vector potential over the surfaces of the elements. The reduction of these equations to a single integral equation is then obtained by the introduction of sequence voltages for the terminal voltages. A numerical solution of this equation for each sequence is then developed employing the Gaussian quadrature formula for numerical integration. Dissert. Abstr.

N68-33994 Texas Univ., Austin.
INVESTIGATION OF IONOSPHERIC ERRORS IN THE DOPPLER SHIFT OF CW SIGNALS FROM ARTIFICIAL EARTH SATELLITES
Arnold Joseph Tucker (Ph.D. Thesis) 1967 100 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-14894

Radio waves transmitted from artificial earth satellites through the earth's ionosphere are affected by the physical properties of the ionosphere. These radio waves are subjected to phase delay, refraction, and attenuation, which cause inaccuracies in the measurement of the Doppler shift of cw signals. In order to understand the effect of these ionospheric errors, a theoretical expression for the refracted Doppler shift has been derived which is a power series in terms of the frequency of the signal. A computer program has been written that uses ray theory in conjunction with an ionospheric model to evaluate each term of this expression. The cause of these ionospheric errors is discussed and the relative importance of each term determined. The first and third order ionospheric errors are shown to be the most significant; these are errors caused by phase delay along the geometric path and by refraction, respectively. Dissert. Abstr.

N68-33997*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
A MEASURABLE EFFECT OF GENERAL RELATIVITY IN SATELLITE ORBITS
E. M. Gaposchkin and James P. Wright 1 Aug. 1968 10 p refs
(Grant NSR-09-015-018)
(NASA-CR-96745; SAO Special Rept.-283) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The reduction of data for satellites having a one-way Doppler system should include the general relativistic terms. There is a general relativistic correction term, which should be used in obtaining the velocity of a satellite from the observed frequency, that is periodic and proportional to the eccentricity. The effect should be observable for satellites with an eccentricity greater than 0.05. It should also be possible to measure the effect directly by using single and double Doppler systems simultaneously from the same earth location. Author

N68-34005*# Michigan Univ., Ann Arbor. Radio Astronomy Observatory.
THE CURRENT DISTRIBUTION ON RESISTIVE LINEAR ANTENNAS
W. H. Schoendorf Feb. 1968 17 p refs
(Grant NGR-23-005-131)
(NASA-CR-96626; Rept.-68-9) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The purpose of this work is to determine the effect of resistive losses on the current distribution of long, thin cylindrical antennas. The first section of this report describes a computational technique for obtaining the current on a thin antenna. Section II presents the results obtained for a 1 1/2 and a 3 wavelength antenna. These calculations were performed for a variety of source positions and for perfectly conducting and uniform lossy wires. The resistance per unit length of these imperfectly conducting wires was taken as 0.08565 ohms/meter. This choice was made in order to accentuate the effects of antenna losses and is larger than the value which will be encountered in the KWOT structure. The final section describes an approximation to the current distribution which allows the resistive losses to be estimated and then extended to antennas longer than those considered in this work. Author

N68-34007# TRW Systems Group, Redondo Beach, Calif.
COMPOUND PHASE-LOCKED LOOP RECEIVER
V. Z. Viskanta [1968] 23 p refs

In this paper a coherent receiver which can be considered as a combination of carrier and modulation tracking loops is investigated. This receiver, in addition to the conventional low-pass filter, includes a parallel bandpass filter for recovery and feedback of the modulation. The linear model of this system is derived and the performance above threshold computed. It is shown that for a narrowband modulating signal with high modulation index, large performance improvement over the conventional carrier tracking phase-locked loop may be obtained. Such compound loops have already been proposed for the reception of fixed tone ranging signals and for the FM demodulation of widely separated narrowband subcarriers. Author

N68-34024# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
SOME NOTES CONCERNING THE FOURIER TRANSFORMATION OF AUTO-CORRELATION FUNCTIONS [QUELQUES NOTES SUR LA TRANSFORMEE DE FOURIER DES FONCTIONS D'AUTOCORRELATION]
Bernard Froelicher and Abdi Dalfes Jan. 1968 39 p refs In FRENCH; ENGLISH summary
(CEA-R-3334) CFSTI: HC $3.00/MF $0.65

The passage of the autocorrelation function to the frequency spectrum was studied by a numerical Fourier transformation. Two principal characteristics of autocorrelation functions, the time between two points and the total time, are related to two oscillations which appear in the frequency spectrum and which deform it.

Various methods are proposed for reducing the effect of these two parasitic oscillations and for re-obtaining the real spectrum. Author (ESRO)

N68-34025# Centre National d'Etudes Spatiales, Bretigny-sur-Orge (France). Department Etudes.
TELEMETRY-TELECOMMAND AND LOCALIZATION SYSTEM FOR STRATOSPHERIC BALLOONS [SYSTEME DE TELEMESURE-TELECOMMANDE ET LOCALISATION POUR BALLONS STRATOSPHERIQUES]
J. Saint-Etienne, J. Beaucher, and G. Delmas 10 Apr. 1967 36 p In FRENCH Conf. Presented at Aire-sur-Adour, France, 29 Mar. 1967
CFSTI: HC $3.00/MF $0.65

The French balloon launching base at Aire-sur-L'Adour will be equipped with new equipment in 1969. This equipment will perform telemetry telecommand and localization. Operation mode of this equipment is analyzed and its performance discussed. ESRO

N68-34026 Societe Anonyme de Telecommunications, Paris (France).
FM/FM TELEMETRY. PART 2: EQUIPMENT AND OPERATION CHARACTERISTICS [LES TELEMESURES FM/FM. PARTIE 2: LES MATERIELS ET LEURS CARACTERISTIQUES D'UTILISATION]
Boissinot Mar. 1967 27 p In FRENCH Presented at the School on the Technol. of Space Expt: Sponsored by the CNES
CFSTI: $3.00

A computation method for a modulation program is given. AJAX telemetry equipment is described. ESRO

N68-34043 North Carolina State Coll., Raleigh.
THE LOOP ANTENNA LOADED WITH ACTIVE ELEMENTS
Charles William Bostian (Ph.D. Thesis) 1967 217 p
Available from Univ. Microfilms: HC $9.90/Microfilm $3.00 Order No. 67-11974

An integral equation particularly suited for numerical solution is derived for the current distribution on a symmetric circular loop antenna. A computer solution of the integral equation is developed and used to analyze cases of interest. Current distributions, radiation patterns, and input admittances are compared. The loop antenna containing a single load diametrically opposite the feed point is treated in detail. Its characteristics are explained in terms of traveling waves on an equivalent uniform transmission line and the parameters of such an equivalent line are calculated. Conditions for the phase velocity reversal associated with negative resistance loads are derived and it is shown that this phenomenon can cause a 180° spatial rotation of the radiation pattern in the plane of the loop. Multiply and continuously loaded loops are considered. Dissert. Abstr.

N68-34048# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
A MODIFIED MATCHED FILTER APPLIED TO PROBLEMS OF RECOGNITION
Alex Grumet Aug. 1968 41 p refs
(RM-422)

A technique is described for designing a recognition device that can discriminate between various signals, choosing the pre-selected one. Similar or very large amplitude dissimilar wave shapes may be rejected by a pair of modified matched filters that separately process the low and high frequency portions of the signal spectrum. The output of the filters when properly combined can result in a very low false alarm probability. The application of this method is demonstrated for a specific wave shape, and it is shown that deterioration of the shape or width of the particular signal pulse will result in its correct rejection. Author

N68-34074# European Space Operations Centre, Darmstadt (West Germany).
THE ESRO TELEMETRY, TELECOMMAND AND TRACKING NETWORK, PART 2
G. C. Tootill *In* ESRO Bul. No. 3, 1967 p 9-14 (See N68-34072 21-30)

The method of spacecraft position determination and the coverage and capabilities of the network for various types of satellites are dealt with. ESRO

N68-34082# European Space Operations Center, Darmstadt (West Germany).
THE ESRO TELEMETRY, TELECOMMAND AND TRACKING NETWORK, PART 1
G. C. Tootill *In* ESRO Bull. No. 2, 1967 p 1-4 (See N68-34081 21-30)

The four ESTRACK stations at Redu, Ny Alesund, Fairbanks and Port Stanley are briefly reviewed and the data acquisition and data processing facilities are described. ESRO

N68-34129# Standard Electrik Lorenz A. G., Stuttgart (West Germany).
DEVELOPMENT OF PCM TELEMETRY ENCODER AND PCM COMMAND DECODER FOR A RECOVERABLE SOUNDING ROCKET FOR RESEARCH OF THE UPPER ATMOSPHERE (PROJECT 621) [ENTWICKLUNG DES PCM-TELEMETRIE-KODIERERS UND DES PCM-KOMMANDO-DEKODIERERS FUR EINE RUCKFUHRBARE HOHENFORSCHUNGSRAKETE (PROJEKT 621)]
H. Kallerhoff May 1968 32 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMWF-FBW-68-33) CFSTI: HC $3.00/MF $0.65

Project 621 of the German national space program covers the development of a recoverable rocket system for research of the upper atmosphere. Testing of the system requires transmission of telemetry data from the rocket to the ground station and commands from the ground station to the rocket. This paper describes the construction of the spaceborne telemetry and command equipment. The equipment has 16 analog and 14 digital telemetry channels, and 3 analog and 4 digital command channels. The report deals with the operation as well as the electrical and mechanical structure of the equipment consisting of a PCM telemetry encoder and a PCM command decoder. Author (ESRO)

N68-34140# Royal Aircraft Establishment, Farnborough (England).
REDESIGN OF FUEL PUMP MOTOR TYPE FB11 REF. 5 UE 6235 TO REDUCE AUDIO FREQUENCY INTERFERENCE
T. J. Davies Oct. 1967 14 p
(RAE-TR-67269) CFSTI: $3.00

Detailed data are given on the changes made to the design of a dc fuel pump motor in order to reduce the LF interference it produced, and the levels of ripple voltage before and after these changes were made are compared. Author

N68-34141 Newark Coll. of Engineering, N. J.
LINEAR AND ADAPTIVE DELTA MODULATION
John Edward Abate (Ph.D. Thesis) 1967 190 p
Available from Univ. Microfilms: HC $8.60/Microfilm $3.00 Order No. 67-14245

New results are presented offering insight into the performance and optimization of linear and adaptive delta modulation, together with a comparison with pulse code modulation. The results are applied to three cases of practical importance: television, speech, and broadband signals. The results presented can be grouped into the following three categories. First, a performance characterization of linear delta modulation (DM) is given. With the aid of certain empirical observations made from computer simulations, closed form expressions are found for granular noise, overload noise, and

minimum quantization noise powers. Second, the advantages to be gained when adaptive control is introduced into the DM system are investigated. Third, the noise performance of PCM with Gaussian and exponential signal densities is presented together with a comparison between DM and PCM for television, speech, and broadband message signals. Dissert. Abstr.

N68-34156* ADCOM, Inc., Palo Alto, Calif.
SATURN TELEMETRY DATA COMPRESSOR TEST PROGRAM Final Report
Carl D. Labmeier 20 Apr. 1968 164 p
(Contract NAS8-21204)
(NASA-CR-61938; G-108) CFSTI: $3.00 CSCL 09F

Pulse frequency modulation telemetry data from Saturn Flights AS-202, AS-203 and AS-204 were processed through a zero-order predictor data compressor. Tests initially specified for this test program required revision to avoid buffer memory saturation. Therefore to meet program objectives, several new test programs were generated for each flight. For the three Saturn flights, 153 total test runs were generated to study the buffer memory behavior as a function of the data compressor control parameters. Buffer fullness values were measured from the test run visicorder records and plotted for comparative analysis. Analysis results showed that the data compression ratio obtained for the high-activity periods varied from 2.0 to 6.5. Test runs generated with 1K tolerance assignments had an average data compression ratio of 2.5; in comparison, test runs operating at the 4K tolerance value had an average data compression ratio of 4.95. This compression ratio improvement could not be clearly attributed to either the rejection of system noise or redundant data samples. Author

N68-34167# Centre National d'Etudes Spatiales, Bretigny-sur-Orge (France). Div. Fusees Sondes.
ANTENNAS FOR SOUNDING ROCKETS [LES ANTENNES POUR FUSEES SONDES]
P. Imbert [1967] 19 p refs In FRENCH Presented at the School on the Technol. of Space Expt. Sponsored by the CNES
CFSTI: HC $3.00/MF $0.65

Antenna characteristics, operation mode and assembly on sounding rockets are discussed, as well as their application to Belier, Centaure and Dragon sounding rockets. ESRO

N68-34174# Laboratoire Suisse de Recherches Horlogères, Neuchatel (Switzerland).
TRANSFORMER TO ADAPT A VERTICAL ANTENNA TO A 50 OHM COAXIAL FEEDER. HBG RECEPTION [TRANSFORMATEUR D'ADAPTATION D'UNE ANTENNE VERTICALE A UNE LIGNE COAXIALE DE 50 OHMS. RECEPTION DE HBG]
P. Kartaschoff Jun. 1967 10 p ref In FRENCH *Its* Res. Proj. No. 0808
CFSTI: HC $3.00/MF $0.65

Characteristics of a transformer to be included in the line linking an antenna to a radio receiver are calculated so that the impedance of the antenna is to be adapted to the impedance of the line and the signal reception is to be optimized. ESRO

N68-34179# Centre National d'Etudes Spatiales, Bretigny-sur-Orge (France). Div. Fusees Sondes.
TRAJECTORY ANALYSIS WITH RADAR TRANSPONDERS [TRAJECTOGRAPHIE A L'AIDE D'UN REPONDEUR RADAR]
Alain Simon Mar. 1968 24 p In FRENCH Presented at the School on the Technol. of Space Expt. Sponsored by the CNES
CFSTI: HC $3.00/MF $0.65

Characteristics of French standard radar equipment and radar transponders are given and applied to a radar-rocket-radar link. Position of the tracking radar on the launching site is discussed. ESRO

N68-34242*# Texas Instruments, Inc., Dallas. Equipment Group.
COMBINED ACQUISITION AND TRACKING RADAR. A PARAMETRIC STUDY Final Technical Report
Jul. 1968 438 p refs
(Contract NAS9-7678)
(NASA-CR-92249; U1-941405-01) CFSTI: HC $3.00/MF $0.65 CSCL 17I

To support design parameters for development of a phased-array radar system to be used as an experiment on board an Apollo spacecraft, investigations were conducted into radar subsystem areas which are most affected by the phased-array nature of the antenna. These areas included antenna, array components, signal processing, data processing, thermal control, and reliability. Candidate system configurations include corporate-fed, active element arrays and space-fed, front- or rear-illuminated arrays. The frequency range of interest is 1.5 GHz to 20 GHz. The nominal tracking problem is to be able to acquire and track a 50 m^2 target at a range of 100 nm. Early parts of the study result in a weight limitation on the radar of 350 pounds, a size limitation on the array of a six-foot diameter, and a prime power limitation of 1000 watts to the array. Under these limitations an optimization procedure is performed which maximizes the returned signal-to-noise ratio for each of six discrete frequencies chosen as candidates, and for the three types of arrays. The optimum system under the assumed limitations included a 292-element, 1.5-GHz corporate-fed, active-element array which yielded satisfactory acquisition and tracking performance at a range of 110 nm for a 50 m^2 target. Author

N68-34272*# ADCOM, Inc., Cambridge, Mass.
DEVELOPMENT OF ADVANCED DIGITAL TECHNIQUES FOR DATA ACQUISITION PROCESSING AND COMMUNICATION Interim Scientific Report
J. Levy, E. H. Gavenman, and W. R. Bechtold 1 Nov. 1967 68 p refs
(Contract NAS12-554)
(NASA-CR-86094) CFSTR: HC $3.00/MF $0.65 CSCL 17B

Work was conducted in the following areas: (1) characterization and description of image data sources, study methodology, imaging missions, imaging sensors, and image fidelity criteria; (2) second order interpolation and pictorial material compressed thereby; (3) sensitivity to compressed pictures to errors, simulation, effect of bit errors upon a picture compressed in accordance with zero order interpolation, and effect of the same noise upon the picture when a simple line substitution error control scheme is employed; and (4) simulation test of analog to digital mapping technique which assigns l-bit sequences to each of the 2^l quantized signal levels so as to cause single bit errors to translate into large quantum level displacements. Author

N68-34278*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
MSFN RELIABILITY: A SUMMARY OF THEORY AND RESULTS
F. Kalil and R. Wigand Jul. 1968 71 p refs
(NASA-TM-X-63323; X-934-68-299) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Reliability-performance data on AS-502, when combined with data from AS-501 and 204 to provide the largest available statistical basis, indicated a mean time between failure (MTBF) of 100 hours for the unified S-band system during mission status. The 90-percent confidence limits for this MTBF of 100 hours were 54 hours and 182 hours. All reported failures were considered (i.e. hardware, software, and operations) throughout the mission status period, which commences about 2 weeks prior to launch and terminates at the end of mission. The MTBF during flight time was 180 hours, and the availability was 99.5 percent. There was insufficient data during the short flight times (35 hours and 28 minutes total for the three flights) to determine meaningful confidence limits. Author

N68-34309*# Varian Associates, Palo Alto, Calif.
RESEARCH AND EXPERIMENTAL STUDY FOR THE DEVELOPMENT OF A 1000 WATT CW SPACE ENVIRONMENT S-BAND POWER AMPLIFIER
R. B. Nelson, W. G. Abraham, E. Lien, W. Harman, G. Bernstein et al [1968] 376 p refs Sponsored by NASA
(NASA-CR-66648) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The purpose of this program was to investigate all the promising types of amplifiers for a 1-kW, S-band spacecraft transmitter, to provide the basis for the best choice for any particular mission. The approach was to make detailed design studies of four specific microwave tubes: a magnetically focused klystron, an electrostatically focused extended-interaction klystron, a helix-circuit traveling wave tube, and an axial-injection crossed-field amplifier. These studies were mainly calculations, cold tests, and proposed mechanical designs, but some experiments were performed on obscure features. A reliability study was made of existing klystrons which may be applicable to many of the devices investigated. Experimental work was done in two areas of tube technology: thermal dissipation in a ceramic-supported slow-wave circuit and improvements in high-temperature beam collectors which radiate directly into space. The results of the device studies were critically compared with each other and with other types not extensively studied. Author

N68-34312# Federal Aviation Administration, Atlantic City, N. J. National Aviation Facilities Experimental Center.
PRELIMINARY INVESTIGATION OF THE NAS STAGE A BACKUP CHANNEL AS RELATED TO THE RESOLUTION AND DETECTION OF AIRCRAFT Final Report
Clifford Chapman Oct. 1968 36 p refs
(NA-68-39)

A preliminary investigation of the backup channel of the National Airspace System (NAS) at the Air Route Traffic Control Center (ARTCC) in Jacksonville, Florida, was performed to obtain advance information relative to the resolution characteristics and the target-detection-in-clutter capability of the backup channel. Equipment comprising the backup channel were the radar/beacon/common digitizer facility at Valdosta, Georgia, the modems and telephone data lines, and the data filter group/bright display equipment at the ARTCC. Test data were collected concurrently on the backup channel and the broadband radar system to permit a comparison between the two systems. The overall system resolution capability of the backup channel for radar, beacon and radar/beacon was comparable to that of the broadband radar system. Author

N68-34313# ITT Industrial Labs., Ft. Wayne, Ind.
SOLID STATE PPI RESOLVED SWEEP GENERATOR Final Report
W. Greutman May 1968 44 p Prepared for FAA
(Contract FA-67-WA-1757)
(RD-68-29)

This program was performed to provide a 100% solid state antenna follow-up system with resolved sweep generators of small size, high reliability and a high degree of accuracy that is applicable to most present and future, radar display systems having a PPI type presentation. Because of its compactness, it can readily replace portions of many present equipments which now use considerably more volume. The system has no rotating machinery and utilizes only single speed antenna information to generate sin/cosine voltage indications of azimuth. Sin/cos generation is virtually immune to antenna information amplitude variations. The system is capable of high speed tracking of antenna rotation without problems encountered in most electromechanical follow-up servo systems. Author

N68-34322*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMPLEX STOCHASTIC NOISE AND MODULATION
John H. Painter and Someshwar C. Gupta (Southern Methodist Univ.) Jun. 1968 8 p refs Presented at the 1968 IEEE Intern. Conf. on Commun., Philadelphia, 12–14 Jun. 1968
(NASA-TM-X-61230) CFSTI: HC $3.00/MF $0.65 CSCL 09D

Distribution theory is utilized to represent stochastic modulation and noise processes as analytic time functions. These representations are used to obtain new results in single sideband angle demodulation in the presence of noise. Author

N68-34329 Montana State Univ., Missoula.
THE PHASE STABILITY OF A VHF METEOR TRAIL FORWARD SCATTER CHANNEL AND AN APPLICATION: A TIME SYNCHRONIZATION SYSTEM
Daniel Nelson March (Ph.D. Thesis) 1966 175 p
Available from Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-13570

The phase stability of 46.55 MHz forward scatter radio reflections from ionized meteor trails is discussed as an indication of the channel length stability and propagation time delay stability. The theory and experimental procedure are developed to determine the phase changes of each received reflection due to the channel. Tests conducted throughout 24 consecutive hours showed that the channel stability remains essentially constant throughout the day. The phase variations in the received signals caused by the channel did not indicate the 2π radian phase multiplicity between reflections from different principle Fresnel zones. Simultaneous signal paths can exist from either two or more meteor trails or from a single long-lasting trail. Time synchronization systems using the meteor trail reflection channel are discussed. A manual time synchronization system set a clock in Bozeman, Montana, to within ± 20 μsec of a clock in Seattle, Washington. Operators at both terminals observed reflected pulses from the other terminal on oscilloscopes. The vhf meteor trail forward scatter channel used with the semi-automated time synchronization system was not the limiting factor. The time synchronization system was limited by the simple pulse techniques used. Dissert. Abstr.

N68-34333 Johns Hopkins Univ., Baltimore, Md.
ADAPTIVE SIGNAL SORTING IN RAYLEIGH FADING CHANNELS
William Kenneth Sones (Ph.D. Thesis) 1967 123 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-13832

An optimum decision rule has been established for sorting data with initially unknown shapes and perturbed by Rayleigh fading. A method of approximating these somewhat intractable rules is then derived, where the approximations do not severely compromise the quality of the decisions yet permit considerable simplification in implementation. Starting with an arbitrarily specified signal, selected on the basis of energy but with unknown shape, the optimum detector is one comprised of the weighted sum of an energy measure, together with a nonlinear function of the correlation of the data with the signal estimates. As knowledge of the signal improves, the weighting changes, and as the signal level varies, the form of the nonlinear function of the correlation changes; thus, for a detector to remain optimal, adaptation, or system modification becomes very complicated. The theoretical aspects of the problem are dealt with. The difficulties of an engineering realization of these mathematical rules are considered, and a near-optimum detector is proposed. The particular approximation suggested for the small signal, Rayleigh fading problem is then investigated, and a simulated experiment conducted to compare this with the optimum. Two experiments were conducted for each of two signals selected from the collection, and the false alarm, false dismissal, and false acceptances observed using first the optimum rule then the approximate. Dissert. Abstr.

N68-34341# Inter-Range Instrumentation Group, White Sands Missile Range, N. Mex.
IRIG STANDARDS FOR RADIO COMMAND SYSTEMS, 4400-5000 MC/S
Aug. 1967 15 p
(IRIG-103-67; AD-672254)

These requirements establish the minimum performance and design requirements for radio command systems to be used in the 4400 - 5000 Mc/s band on missile test ranges for the command and control of aircraft, guided and ballistic missiles, and captive vehicles. This system will be required to form compatible interface with existing test range operational command and control systems and equipment. The system capability is such that its use can be easily extended to support satellite and other range-user research vehicles. Author (TAB)

N68-34406 Allgemeine Elektrizitaetsgesellschaft, Konstanz (West Germany).
READINGS OF DIGITALIZED RADAR DATA [ANZEIGE DIGITALISIERTER RADARDATEN]
Wolfgang Schmidt [1968] 11 p In GERMAN

Described is a digitalization system for multiple radar signals and the subsequent evaluation and application to aircraft control. Primary as well as secondary radar signals are digitalized under inclusion of flight position and target data. Transl. by G.G.

N68-34408# Bausch and Lomb, Inc., Rochester, N. Y. Research and Development Div.
INFRARED COATING STUDIES Quarterly Report, 15 Mar.-15 Jun. 1968
A. F. Turner Jun. 1968 31 p refs
(Contract DA-44-009-AMC-1707(E))
(QR-8; AD-672515)

This contract series has carried out studies of reststrahlen films. These are films whose crystallite structure is sufficiently well developed to produce the high metallic-like reflectance characteristic of the infrared reststrahlen band of the parent massive crystalline material. The development of reststrahlen films has two broad purposes: first, for infrared reflection filtering purposes in the classical manner, with the advantage of sizes limited only by the size of the vacuum coater available; and second, to furnish new film components with unique optical properties for incorporating in infrared coatings designed for filtering and thermal emittance control. The present quarterly report describes induced transmission filters utilizing MgO and LiF reststrahlen films at wavelengths within their reststrahlen bands, 14 to 25 microns and 15 to 33 microns respectively. The design steps are enumerated and justified by literature references to their theoretical background, or proofs are furnished where these have not been found in the open literature. Author (TAB)

N68-34417# Rome Univ. (Italy).
DATA REDUCTION SYSTEMS FOR THE SAN MARCO 1 SATELLITE [SISTEMI DI RIDUZIONE DEI DATI DEL SATELLITE SAN MARCO 1]
Paolo Santini Jun. 1967 16 p refs In ITALIAN; ENGLISH summary *Its* Atti del Centro Ric. Aerospaziali 15-h
CFSTI: HC $3.00/MF $0.65

The method of data reduction employed for the atmospheric experiment of the San Marco 1 satellite is described. Using an analog-to-digital converter, leads to obtain the instantaneous value of the resultant of the forces acting on the satellite are obtained. In order to determine the density value, the signal obtained must be separated from that due to the centrifugal forces caused by both mass eccentricity and residual spin. All this is obtained through a particular smoothing process suitable for electronic computers. Author (ESRO)

N68-34424# Army Electronics Labs., Fort Monmouth, N. J.
MULTIPLE CRYSTAL HOLDER
Joseph M. Giannotto May 1968 19 p
(ECOM-2972; AD-672064)

A novel quartz crystal packaging technique has been developed which has resulted in reducing the volume of a complete filter by over 60%. This technique involves the mounting of three quartz crystals, each resonant at a different frequency, in a can normally used for one crystal blank. This report will present a detailed description of the mounting technique and the electrical characteristics of a complete SSB filter using this novel mounting method. Author (TAB)

N68-34457# Stanford Univ., Calif. Dept. of Statistics.
LARGE-SAMPLE PROPERTIES OF LEAST-SQUARES ESTIMATORS OF HARMONIC COMPONENTS IN A TIME SERIES WITH STATIONARY RESIDUALS. 1. INDEPENDENT RESIDUALS
A. M. Walker Jul. 1968 35 p refs
(Grant DA-ARO(D)-31-124-G726)
(AROD-2055-23-M; TR-23; AD-672519)

Let X sub t be a discrete parameter time series generated by a model such that E(X sub t) is the sum of a finite number of simple harmonic terms of the form A cos omega t + B sin omega t, and X sub t - E(X sub t) is a moving average of independently identically distributed random variables epsilon sub t, whose weights g sub u (theta) are specified functions of a vector-valued parameter theta. In 1952 P. Whittle proposed an approximate least-squares method of simultaneously estimating theta and the angular frequencies, sine and cosine coefficients of each harmonic term from observations X sub 1, X sub 2,...,X sub n, and derived heuristically the asymptotic (n approaching infinity) distribution of the estimators. This paper presents rigorous proofs of Whittles statements concerning the asymptotic distribution, formulated precisely as limit theorems, for the simpler but important case where the moving average reduces to epsilon sub t, so that the parameter theta disappears. Proofs for the general case will be given in a subsequent paper. Author (TAB)

N68-34471# Illinois Univ., Urbana. Coordinated Science Lab.
A CLASS OF OPTIMUM NONLINEAR DOUBLE ERROR CORRECTING CODES
Franco P. Preparata Jul. 1968 38 p refs
(Contract DAAB-07-67-C-0199; Grant NSF GK-2339)
(R-389; AD-672487)

Nonlinear double-error-correcting binary codes of length (2 to the nth power)-1 are presented in this paper. They can be encoded as systematic codes and have the largest possible number of code words for their length and minimum distance, that is, are optimum. The complexity of the encoding and decoding operations is comparable to the one of the corresponding linear codes. Author (TAB)

N68-34486# Sylvania Electric Products, Inc., Waltham, Mass. Applied Research Lab.
ELF AND VLF IN THE SPHERICAL GUIDE BETWEEN THE EARTH AND THE IONOSPHERE
Janis Galejs May 1968 113 p refs
(Contract Nonr-3185(00))
(RR-554; AD-672547)

The wave guide is excited by vertical or horizontal electric or magnetic dipole sources, and its boundaries are characterized by surface impedances. The resulting waves are expressed as a superposition of TM and TE modes. The wave numbers, excitation factors, height-gain functions, and height-dependent impedances are examined for both types of modes. Author (TAB)

N68-34498# Sylvania Electric Products, Inc., Waltham, Mass. Applied Research Lab.
ELF & VLF FIELDS OF A HORIZONAL ELECTRIC DIPOLE
Janis Galejs Jul. 1968 37 p refs
(Contract Nonr-3185(00))
(RR-555; AD-672548)

The waves in the spherical guide between the earth and ionosphere are excited by a horizontal electric dipole. The guide boundaries are characterized by surface impedances, and the resulting waves are expressed as a superposition of TM and TE modes. The wave numbers, excitation factors, height-gain functions, and height-dependent impedances are examined for both types of modes. Author (TAB)

N68-34565*# Massachusetts Univ., Amherst. Electrical Engineering Dept.
AN ANALYSIS OF THE EFFECT OF A PARTICULAR CLASS OF PFM ON NOISE INPUTS
C. E. Hutchinson and Y. T. Chon [1968] 21 p refs Presented at the IEEE Natl. Telemetering Conf., Houston, Tex., 11 Apr. 1968
(Grant NGR-22-010-018)
(NASA-CR-96822) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Because Pulse Frequency Modulation (PFM) provides a high degree of immunity to noise, it is presently of interest in many modern communication and control systems. This paper presents a quantitative statistical analysis of PFM systems with a noise input (namely, white noise). Some concepts of the Impulse process and the first passage time problems of diffusion process are introduced, which are analogous to the noise transmission of PFM systems. The autocorrelation and spectral density functions are determined for the output of the PFM system with a white noise input. A comparison between the analytical and experimental results is presented. Author

N68-34567*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
FILTER PROPERTIES OF LEAST SQUARES FITTED POLYNOMIALS
Bodo Kruger Jan. 1968 39 p refs
(NASA-TM-X-63321; X-551-68-147) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The use of least squares fitted polynomials (LSP) as high and low pass filters is analyzed in this paper. A typical high pass filter application is noise analysis of tracking data. Equations are given for the estimation of degrees of freedom k needed in the LSP in order to take out the orbit so that the residuals (tracking data–LSP) represent the tracking data noise. As the LSP only contains k terms, the orbit is not completely taken out and what is left over of the orbit in the tracking data is called the modeling error δ. It is shown that the standard deviation of δ is proportional to T^k and $Y^{(k)}$ where T = the length of the data stretch; and $Y^{(k)}$ = k^{th} derivative of the orbit. The modeling error is analyzed in some detail for a lunar orbit and it is shown that k = 7 is needed for both range and range rate data if the standard deviations σ_r and $\sigma_{\dot{r}}$ of the modeling errors have to satisfy $\sigma_r < 10$ m and $\sigma_{\dot{r}} < 1$cm/sec and if the data stretch is 1/4 revolution, starting at the earth–moon line. Author

N68-34602# Naval Research Lab., Washington, D. C.
THE SCATTERING OF A PLANE ELECTROMAGNETIC WAVE BY A LINEAR ARRAY OF CENTER-LOADED CYLINDERS Final Report
O. D. Sledge 6 Jun. 1968 45 p refs
(ARPA ORDER 820)
(NRL-6681; AD-672182)

The scattering properties of a linear array of parallel, center-loaded, cylindrical elements have been investigated with the ultimate objective of obtaining information about the character of the array from its scattered field. To this end, a set of integral equations for the currents induced in the linear array illuminated by an incident plane wave were derived from the equations of Maxwell and the boundary conditions at the surface of the array. Using a zero-order approximation to the form of the axial distribution of the induced currents in the array, a pair of complex current coefficients were calculated numerically for each element of the array using a technique incorporating the set of integral equations. The approximation technique gives reasonable accuracy in the calculation of the H-plane, far-zone, scattered field from the induced currents, provided the electrical half-length of the elements of the array is less than 5 pi/4 radians. Author (TAB)

N68-34604# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FILTRATION OF TIME-QUANTIZED PERIODIC SIGNALS [O FILTRATSII PERIODICHESKIKH SIGNALOV, KVANTOVANNYKH PO VREMENI]
E. V. Seregeev Sep. 1967 11 p Transl. into ENGLISH from Geofiz. Apparatura (USSR), no. 26, 1965 p 84–89
(FTD-HT-67-292; AD-672191)

Two methods are considered for filtration of a discrete signal. The first method consists of using an integrator to convert the discrete signal to a continuous quantity with subsequent filtration by a continuous filter. The second method consists of adding the values of the signal taken at discrete instants during a certain time interval. Block diagrams are given of the devices used for filtration by both these methods. A comparison of these two filtering methods shows that the second method gives higher accuracy and requires less time for determining the value of the constant components. TAB

N68-34626# Parke Mathematical Labs., Inc., Carlisle, Mass.
A SERIES EXPANSION METHOD FOR THE PREDICTION OF THE FAR FIELD FROM NEAR FIELD MEASUREMENTS
John L. Butler Jul. 1968 55 p refs
(Contract N00014-67-C-0424)
(SR-1; AD-672364)

A series expansion method for determining the far field from near-field measurements of coherent and partially coherent sound fields is described. The method is based on a series expansion of the solution in spherical wave functions truncated to include only the number of terms equal to the number of near-field measuring points. The expansion coefficients may be evaluated through a matrix inversion for near field measuring points at any reasonable location. A comparison of exact and predicted far fields is presented for some simple source distributions, and it is shown that good results can be obtained even for measuring surfaces that do not completely enclose the source. Author (TAB)

N68-34723# Naval Research Lab., Washington, D. C.
IMPEDANCE OF LOFTI IIA VERY-LOW-FREQUENCY ANTENNAS IN THE IONOSPHERE Final Report
C. E. Young 18 Jun. 1968 27 p refs
(NRL-6712; AD-672180)

The spacecraft of the LOFTI IIA transionospheric very-low-frequency (vlf) receiving experiment was fitted with relatively simple automatic instrumentation for periodic indication of vlf antenna admittance in the 10 to 18 kHz range. Author (TAB)

N68-34808# Stanford Research Inst., Menlo Park, Calif.
AN APPROXIMATE EXPRESSION FOR THE COST-GAIN RELATIONSHIP IN LARGE PARABOLIC ANTENNAS Final Report
B. R. Stack Dec. 1967 46 p refs

An approximate formula is developed for application to large parabolic antennas that permits the determination of cost as a function of required gain at a specified frequency. Author

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N68-33732 Northwestern Univ., Evanston, Ill.
DECISION TABLES AND SIMULATION
Herbert Reinard Ludwig (Ph.D. Thesis) 1967 298 p
Available from Univ. Microfilms: HC $13.50/Microfilm $3.85 Order No. 67-15279

Two areas were investigated: the basic structure and algorithms used in translating decision tables into computer programs on a digital computer, and the application or use of decision tables in simulating. The major contribution of the work is in the first formal presentation of the algorithms used for translating decision tables into computer programs and in the application of decision tables to the area of simulation. The reader is provided with the basic tools necessary to analyze a decision table for completeness, redundancies, and inconsistencies. AND-FUNCTION theorems and OR-FUNCTION theorems pertaining to the decision rules of a decision table are presented in order that the reader and programmer of decision table translators can verify his own logic. A detailed presentation is given on the algorithms used in translating decision tables into computer programs. Special emphasis is placed on the computer code —FORTRAN— generated by these algorithms.
Dissert. Abstr.

N68-33742*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ISIS-A EXPERIMENT DATA PROCESSING AND DISPLAY CONSOLE
Robert W. Rhodes Jul. 1968 13 p
(NASA-TM-X-63319; X-324-68-279) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A data processing and display system designed for the ISIS-A spacecraft is described. The system was designed to fulfill two specific needs. It provides displays for the five experiments for which displays are not available in the RCA Victor (RCAV) ground station equipment (GSE), and it provides backup decommutation capability for the PCM data signal. The system can accept data from the RCAV GSE or provide its own data and synchronization signals from the outputs of its self-contained receivers. The system was designed using commerical equipment and logic cards wherever possible. The general logic design was straightforward and is not presented in detail.
Author

N68-33761 California Univ., Los Angeles.
SYSTEM DETERMINATION FROM NOISY MEASUREMENTS
Jack Kenneth Holmes (Ph.D. Thesis) 1967 84 p
Available from Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-14307

This dissertation presents a theoretical and computational study of a method to identify an unknown, nonlinear, finite memory system in which the input or output may be noise corrupted. The method of solution is a stochastic steepest descent method yielding a very simply programmed algorithm which has one parameter to be specified. Essentially no knowledge of the noise or signal statistics are needed to use this algorithm, that is to say it is a non parametric method. Further, no *a priori* knowledge of the system is needed, such as for instance, that the system satisfies a certain differential equation, except of course we require that it be stationary in time. To be useful an algorithm must always converge. Hence the algorithm is shown to converge to the best mean square estimate in the limit as more and more data is used. The asymptotic rate of decrease of the mean squared error is also obtained. The dissertation is concluded with computer results for some data obtained from a control system.
Dissert. Abstr.

N68-33784 California Univ., Berkeley.
INTERCOMMUNICATION OF DIGITAL COMPUTER PROCESSORS AND MEMORIES
Melvin Wiley Pirtle (Ph.D. Thesis) 1967 40 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-11657

Certain aspects of the problem of effective processor-memory intercommunication with digital computer are discussed. The concepts of memory bandwidth and memory bus bandwidth are considered along with methods of supplying ample quantities of these resources to the processors (CPU and I/O processors or channels). A priority mechanism used to resolve conflicting requests on the memory system is suggested. With this mechanism, priorities are assigned to individual requests on the basis of immediate requirements and conditions; this contrasts with the current practice of assigning priorities to processors. This flexibility of priority assignment frequently allows a processor to make low priority, minimum interference requests instead of high priority requests, since processors must make high priority requests only when the memory reference is required immediately. To minimize the frequency of high priority requests made by I/O processors, a buffering scheme is suggested for these processors which frequently extends the interval in which they may make a memory reference.
Dissert. Abstr.

N68-33830*# Analytical Mechanics Associates, Inc., Lanham, Md.
SUBOPTIMAL FILTERING. PART 4: TEST-BED COMPUTER PROGRAM Final Report
Andrew H. Jazwinski, Stanley F. Schmidt, Ann E. Bailie, and Norman Levine May 1968 6 p ref
(Contract NAS5-11048)
(NASA-CR-96545; Rept.-68-12, Pt. 4) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A brief outline is given on the test-bed computer program which is being developed to simulate real observation schedules and combined effects of dynamic model errors in three-dimensional satellite motion. The program consists of two decks: part 1 generates an observation tape which is processed by filters in part 2.
Author

N68-33966# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ASYNCHRONOUS SEQUENTIAL MACHINE WITH A PREDETERMINED DEGREE OF RELIABILITY
Wen-Chen Lin 25 Aug. 1967 19 p refs Transl. into ENGLISH from Tzu Tung Hua Hsueh Pao (China), v. 4, no. 1, 1966 p 37-45
(FTD-HT-67-32; AD-671738)

The author describes the synthesis of an asynchronous sequential relaying circuit with its predetermined reliability. The relaying circuit is assumed to have n relays in both the controlling and controlled circuits separated by distance D. The n-D relays at corresponding positions in both the controlling and controlled circuits are in the same operating state and the D relays in different operating states. The operating state of both the controlling and controlled circuits is deviated if one of the n-D relays is in poor condition, while that of either the controlling or the controlled circuit is affected by one of the D relays in poor condition. Analysis shows that the asynchronous sequential relaying circuit can still operate normally with deviated states by using error-correcting codes in state assignment.
TAB

N68-33977 Lehigh Univ., Bethlehem, Pa.
THERMAL HYSTERESIS IN FERRITE MEMORY CORES
Ivan Jerome Sacks (Ph.D. Thesis) 1967 77 p
Available from Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-14952

The switching voltage of nickel–copper–manganese and copper–manganese ferrite memory cores has been found to depend on the difference between the flux storage and the flux retrieval temperature. Setting the core to a flux state at an elevated temperature well below the Curie point, cooling to a lower temperature and switching the core at the lower temperature produces a lower peak voltage and longer peaking time than if the core had been set and switched at the low temperature. Setting the core at the lower temperature, heating, and switching at the higher temperature produces the opposite effect i.e., a higher peak voltage and shorter peaking time. No difference is seen between the switching voltage from a.c. demagnetized state attained at an elevated voltage and the voltage attained from the a.c. demagnetized state attained at the switching temperautre. Dissert. Abstr.

N68-34047# Atomic Energy Commission Research Establishment, Riso (Denmark).

ASYNCHRONOUS SHIFT REGISTER FOR PARALLEL TO SERIAL CONVERSION WITH PROGRAMMED CONTROL

K. B. Hansen Feb. 1968 17 p refs

(RISO-172) CFSTI: $3.00

The parallel to serial conversion register described is used in common bus-structured digital systems together with other functional units. The register is called by special 7-bit-coded symbol address characters, which also select the source of parallel information and initiate the transfer to the register. Another symbol controls the serial read-out from the register. The use of asynchronous control guarantees the correct transfer of information to and from the register independently of the reaction times of the units with which it co-operates. Author

N68-34069*# Arizona State Univ., Tempe. Engineering Research Center.

DEFINITIONS AND PROCEDURES EMPLOYED IN THE GERT SIMULATION PROGRAM

A. Alan B. Pritsker [1968] 64 p refs

(Grant NGR-03-001-034)

(NASA-CR-96711) CFSTI: $3.00 CSCL 09B

This report describes the variables and techniques of a computer program for simulating GERT networks on a digital computer. This GERT simulation program is written in the GASP 2A simulation language and can be run on any computer with a FORTRAN compiler. The GERT simulation program can accommodate GERT networks which have EXCLUSIVE-OR, INCLUSIVE-OR and AND logical operations associated with the input side of a node, and deterministic or probabilistic operations associated with the output side of a node. The branches of the GERT network are described in terms of a probability that the branch is realized and a time to perform the activity represented by the branch. (Time is used throughout this report to represent an additive variable.) The time associated with a branch can be a random variable. The program has been exercised on the IBM 1130 which has a FORTRAN operation set more restrictive than the general FORTRAN 4 operation set. Therefore, the GERT simulation program can be used on most computers which have FORTRAN 4 compilers. Author

N68-34114# Standard Electrik Lorenz A. G., Stuttgart (West Germany).

BASIC DEVELOPMENT OF THE ELECTRONIC CIRCUITS FOR A FERRITE CORE DATA STORAGE DEVICE [GRUNDSAETZLICHE ENTWICKLUNG DER ELEKTRONISCHEN SCHALTUNGEN FUER EINEN FERRITKERNSPEICHER ZUR DATENSICHERUNG]

M. Bohner and M. Florjancic Apr. 1968 30 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung

(BMWF-FBW-68-29) CFSTI: HC $3.00/MF $0.65

Continuing the work on a 2 million bit ferrite core buffer memory, the address selector switches, the drive pulse generators, the sense amplifier, the power supply switch-off circuits and a timer have been developed. Power dissipation, weight and volume have been reduced to a minimum. The circuits have been tested individually under simulated actual electrical conditions. For the digital circuits, a DTL family has been chosen which has already been successfully employed in space projects. Since none of the commercially available memory stacks satisfies the requirements made on this buffer, a special development has been proposed and characteristics have been compiled in a draft specification for this development. Author (ESRO)

N68-34130# National Physical Laboratory, Teddington (England). Central Computer Unit.

A BRIEF GUIDE TO THE NPL GRAPHICAL OUTPUT SYSTEM

C. W. Nott 6 Jun. 1968 18 p refs

(NPL-CCU-2) CFSTI: HC $3.00/MF $0.65

The NPL Graphical Output System whereby diagrams can be easily obtained from KDF9 programs written in Algol or in Usercode is described. Plotting may be performed on any combination of the graphical devices available. The examples concern the setting up of boundaries and frames, the plotting of lines and curves, and the rotation and expansion of graphs. A list of the subroutines to be called in programming and a list of messages due to failures or errors are appended. ESRO

N68-34131# National Physical Lab., Teddington (England). Central Computer Unit.

CONSTRUCTION OF THE CHARACTERS AVAILABLE IN THE NPL GRAPHICAL OUTPUT SYSTEM

B. R. Heap and Margaret Laws May 1968 27 p refs

(NPL-CCU-1) CFSTI: HC $3.00/MF $0.65

The NPL graphical output system implemented on the KDF9 computer contains a wide variety of software characters. These include numerals, the Roman and Greek alphabets, both upper and lower case, punctuation signs, mathematical symbols, and point plotting symbols. Where possible, the characters have been designed to follow closely the OCR 'B' character set which is generally accepted as a standard for character recognition. In this report the characters are displayed and full details of the method of constructing them is given in a form suitable for implementation on other computers. Author (ESRO)

N68-34146# Los Alamos Scientific Lab., N. Mex.

SEMIANNUAL ATOMIC ENERGY COMMISSION COMPUTER INFORMATION MEETING

[1968] 70 p refs Meeting held 20–21 May 1968

(Contract W-7405-ENG-36)

(LA-3930; CONF-680511) CFSTI: HC $3.00/MF $0.65

Summaries of recent research and developments at the various AEC computer centers are presented. NSA

N68-34153# Los Alamos Scientific Lab., N. Mex.

SEMIANNUAL ATOMIC ENERGY COMMISSION COMPUTER INFORMATION MEETING, SUPPLEMENT

[1968] 76 p refs Meeting held 20–21 May 1968

(Contract W-7405-ENG-36)

(LA-3930, Suppl.; CONF-680511(Suppl.)) CFSTI: HC $3.00/MF $0.65

Summaries of recent research and developments at various AEC computer centers are presented in addition to those presented in report LA-3930. NSA

N68-34186*# Arizona State Univ., Tempe. College of Engineering Sciences.

USER MANUAL FOR GERT SIMULATION PROGRAM

A. Alan B. Pritsker [1968] 43 p refs
(Grant NGR-03-001-034)
(NASA-CR-96736) CFSTI: HC$3.00/MF$0.65 CSCL 09B

The procedures for using a digital computer program for simulating GERT networks are described. The simulation program can accommodate GERT networks which have exclusive-OR, inclusive-OR and AND logical operations associated with the input side of a node and deterministic or probabilistic operations associated with the output side of a node. The branches of the GERT network are described in terms of a probability that the branch is realized and a time to perform the activity represented by the branch. The time associated with a branch can be a random variable. The results obtained for the GERT simulation program are: (1) The probability that a node is realized; (2) The average time to realize a node; (3) An estimate of the standard deviation of the time to realize a node; (4) The minimum time observed to realize a node; (5) The maximum time observed to realize a node; and (6) A histogram of the times to realize a node. The program is written to permit the above information to be obtained for any node specified by the input data. The GERT simulation program is written in GASP IIA, a FORTRAN – based simulation language. Author

N68-34308 Arizona Univ., Tucson. Dept. of Electrical Engineering.
AN ECONOMICAL ANALOG TO DIGITAL CONVERTER SYSTEM FOR HYBRID COMPUTERS
J. R. Goltz May 1968 19 p refs
(ACL-MEMO-147)

This paper describes a new economical analog-to-digital converter system which employs separate converters for each channel. Each analog-to-digital converter is a ramp/comparator converter which utilizes one of the existing analog integrators both on a sample-hold circuit and as a precision ramp generator. Each converter channel, then, consists only of an integrated circuit comparator and an integrated circuit gated counter. The expense and errors inherent in these components, as well as in the multiplexer switches, is thus effectively eliminated. While each analog-to-digital conversion now takes between 50 and 270 μsec, this time is effectively divided by the number of conversion channels (4 to 40), since multiplexing is no longer required. The absence of a separate multiplexer also simplifies the digital-computer interface electronics and programming. Author

N68-34338# RAND Corp., Santa Monica, Calif.
AN IMPROVED IMPLICIT ENUMERATION APPROACH FOR INTEGER PROGRAMMING
A. M. Geoffrion Jun. 1968 33 p refs
(Contract F44620-67-C-0045)
(RM-5644-PR; AD-672255)

The report presents a synthesis of the Balasian implicit enumeration approach to integer linear programming with the approach typified by Land and Doig and by Roy, Bertier, and Nghiem. This synthesis results from the use of an imbedded linear program to compute surrogate constraints that are as strong as possible in a sense slightly different from that originally used by Glover. A very simple implicit enumeration algorithm fitted with optional imbedded linear programming machinery was implemented and tested extensively on an IBM 7044 computer. Use of the imbedded linear program dramatically reduced solution time in virtually every case and sufficied to render the tested algorithm superior to the other five implicit enumeration algorithms for which comparable published experience was available. Existing evidence suggests that the present approach should permit the routine solution of practical integer problems involving hundreds of variables. Author (TAB)

N68-34421# International Business Machines Corp., Gaithersburg, Md. Federal Systems Div.
COLOR SEPARATION SYSTEM EVALUATION Final Technical Report, Jun. 1967–Jun. 1968
Donald R. Thompson, J. V. Sharp, and S. R. Gilpin Jan. 1968 55 p refs
(Contract DAAK02-67-C-0463)
(AD-672078)

An experimental optical scanner is capable of detecting and identifying eight different colored pencil lines on a map compilation manuscript. Reflected tungsten illumination, a lens, a single dichroic mirror, and two solid state photosensors are the major elements comprising the color head; the decoding logic is all digital. A scanning rate of 30,000 data bytes per second, plus simultaneous color encoding, can be achieved. A color coding method for the compiler is recommended which would tag each drawn line or point for its position, separation negative, and its TM-23A output symbol. Scanning and computer processing of this color line data for an eventual output negative plotting system is discussed. Author (TAB)

N68-34553# Michigan Univ., Ann Arbor.
TRAMP: A RELATIONAL MEMORY WITH AN ASSOCIATIVE BASE
William Ash and Edgar Sibley May 1968 92 p refs
(Contract DA-49-083-OSA-3050; ARPA Order 716)
(TR-5; AD-672206)

This report describes the theory and implementation of an experimental language called TRAMP, which is a software simulation of a content-addressable memory. The system consists of an associative data structure embedded in an interpretive language, allowing great flexibility and strong recursive power. The system has further been extended with a logical inference capability by superimposing a relational structure over the associative memory. The resulting language has already proved to be extremely powerful in several applications, and can be termed a language for developing question-answering and interactive communication systems. This report discusses the theory and design considerations, details of machine implementation, and details of operation with examples. Author (TAB)

N68-34572# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BASIC PRINCIPLES FOR THE FORMATION OF THE POLIS SYSTEM [OSNOVNYE PRINTSIPY POSTROENIYA SISTEMY POLIS]
L. P. Zhirova 13 Oct. 1967 8 p refs Transl. into ENGLISH from Tr. Sibirskii Fiz.-Tekhn. Inst. (USSR), no. 47, 1965 p 11–14
(FTD-HT-23-1398-67; AD-672336)

The polynomial interpreting system (POLIS) is a programming routine composed of a class of polynomials of dimensions n = 0,1,2, in rational functions for a three-address general purpose computer. Its basic purpose is for realization of analytical operation on polynomials and maintenance of the economy of the immediate access memory of a computer in the process of solution of the problem. TAB

N68-34600# Pennsylvania Univ., Philadelphia. Moore School of Electrical Engineering.
A PROGRAMMING SYSTEM FOR MANIPULATION OF POLYNOMIALS
Xavier Caro May 1968 122 p
(Contract DA-31-124-ARO(D)-98; Grant NSF GP-5661)
(Rept.-68-35; AROD-4166-12-M; AD-672488)

This paper describes a programming system, the LP system for handling polynomials. Author (TAB)

N68-34622# University of Southern Calif., Los Angeles. Electronics Personnel Research Group.
COMPUTER-AIDED TECHNICAL TRAINING USING ELECTRONIC EQUIPMENT ON-LINE WITH THE CAI SYSTEM
Geoffrey Huggett, Daniel J. Davis, and Joseph W. Rigney Jun. 1968 41 p refs Prepared in cooperation with Illinois Univ., Urbana. Computer-based Educ. Res. Lab.
(Contract Nonr-228(22))
(TR-59; AD-672189)

The report describes an experimental course in the operation and troubleshooting of a communications transceiver, the AN/URC-32, in which the transceiver is used as part of an instructional station in a CAI system. The transceiver and the CAI system are hard-wired together to form a single training system. The system is presently operating in the Computer-Based Education Research Laboratory of the University of Illinois. A students operation of switches on the transceiver front panel is sensed by the CAI system. The CAI system can insert and remove malfunctions in the transceiver under program control. This allows practice in operating and troubleshooting the equipment to be coordinated with the presentation of technical information in the lessons. The student is required to put his knowledge of this information to immediate use in solving troubleshooting problems. The report describes the initial implementation of the above features. Author (TAB)

N68-34640# Naval Research Lab., Washington, D. C.
NELIAC-N, THE NAREC VERSION OF THE NELIAC PROGRAMMING LANGUAGE Interim Report
John W. Kallander 6 Jun. 1968 86 p *Its* Computer Reference 1
(NRL-6664; AD-672315)

This report contains a tutorial and the final definitive description of NELIAC-N (the version of the NELIAC language implemented on the NAREC by means of the NELIAC-N compiler), which furnished the transition vehicle between the NAREC and the CDC 3870 being installed at NRL. NELIAC is a problem-oriented, machine-independent programming language which enables programmers, scientists, and engineers to write their programs in a mathematical language rather than requiring an actual machine language or an assembly language. NELIAC thus minimizes the knowledge of the actual computer required by the programmer, maximizes the readability of the programs themselves, and provides carry-over value of programs from one computer to another. Author (TAB)

N68-34683# Joint Publications Research Service, Washington, D. C.
COMPUTERS—BOOLEAN FUNCTIONS AND LINEAR SYSTEMS WITH LUMPED PARAMETERS
16 Aug. 1968 18 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 180, no. 5, 1968 p 1053–1059
(JPRS-46217) CFSTI: HC$3.00/MF$0.65

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1. COMPARISON OF AUTOMATA AND TURING MACHINES WITH RESPECT TO BOOLEAN FUNCTIONS Yu. Ya. Breytbart p 1–6 refs (See N68-34684 21-08)

2. FINITE CONTROL OF LINEAR SYSTEMS WITH LUMPED PARAMETERS A. G. Butkovskiy p 7–13 refs (See N68-34685 21-10)

N68-34684# Joint Publications Research Service, Washington, D. C.
COMPARISON OF AUTOMATA AND TURING MACHINES WITH RESPECT TO BOOLEAN FUNCTIONS
Yu. Ya. Breytbart *In its* Computers—Boolean Functions and Linear Systems with Lumped Parameters 16 Aug. 1968 p 1–6 refs (See N68-34683 21-08)

This article contains an explanation of the role of the external memory of Turing machines when using them to calculate boolean functions. The problem of comparing the complexities of realizations of boolean functions by Turing machines and Turing machines without an external memory (automata) is investigated. Here we understand the complexity of realization of the function $f(x_1, \ldots, x_n)$ by an automaton (a Turing machine, respectively) as the product of the minimum necessary number of internal states of the automaton (the Turing machine respectively) realizing the function obtained from f by a permutation of the variables for the maximum time of calculation of $f(\alpha_1, \ldots, \alpha_n)$ where the maximum is taken with respect to all possible sets $\tilde{\alpha} = (\alpha_1, \ldots, \alpha_n)$ of 0's and 1's of length n. In particular, it is established that the ratio of the complexities of the realizations is no less than $2^{cn-\phi(n)}$ where c and $\phi(n)$ depend only on the set of possible permutations of the variables of the initial function. Author

N68-34749*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A FLEXIBLE LSI SPACEBORNE DATA PROCESSING SYSTEM CONCEPT
R. J. Lesniewski [1968] 10 p refs Presented at the 2d Ann. IEEE Computer Conf., Los Angeles, 25–27 Jun. 1968
(NASA-TM-X-61192) CFSTI: HC$3.00/MF$0.65 CSCL 09B

The use of one or more small processors per experiment is discussed; these spaceborne computers are based on the large scale integration (LSI) concept utilizing complementary metal oxide semiconductor technology. To illustrate the advantages of small programmable decentralized processors, details are given on a parallel ultralow power processor (PULPP). This data processing system consists of four flexible, general purpose LSI arrays which constitute the system's basic building blocks. These arrays are (1) a 288-bit scratch pad memory, (2) a 16-stage parallel processor, (3) a 288-bit read only memory, and (4) a 16-stage input–output memory buffer. Each array is complete with its own encoded instruction set including all the required control, and each is low power in nature with operating powers measured in the low milliwatts and standby powers measured below 5 microwatts. An example is given to show how these arrays can be combined into a 6-chip PULPP system capable of programmed data formatting. The major advantage of such a system is cited as the opportunity it offers the experimenter to fly on many varied spacecraft without altering his computer except to change the program. M.G.J.

N68-34758# Case Western Reserve Univ., Cleveland, Ohio. Systems Research Center.
ADAPTIVE PATTERN RECOGNITION IN GENERAL SYSTEMS THEORY
Joseph John Talavage Jun. 1968 81 p refs
(Contracts Nonr-1141(12); NSF GK-1394)
(SRC-68-7; AD-672552)

The objectives of this document are to set forth general definitions of adaptation and pattern recognition, to test these definitions in a specific practical situation; namely adaptive pattern recognition, and to consider some significant implications of these definitions with regard to the design of adaptive systems. All of this work is done in a General Systems Theory framework which is mathematical and, in particular, set-theoretical in nature. Author (TAB)

N68-34768# Illinois Univ., Urbana. Dept. of Computer Science.
STORAGE OF ANALOG VARIABLES IN DELAY LINES
Lawrence H. Wallman Jun. 1968 131 p refs
(Contract Nonr-1834(15))
(Rept.-268; AD-672317)

An analog storage system has been designed using delay line techniques. The analog storage is accomplished by comparing the analog voltage to be stored with a voltage ramp in a comparison circuit; when equality between voltages is found an output signal

from the comparison circuit triggers a monostable multivibrator which has the same period as the voltage ramp. The monostable multivibrator is made to retrigger by using feedback to control the gating of a trigger pulse. The system is capable of storing any voltage between approximately +10 volts and -10 volts to an accuracy of 1% of the full range. Several possibilities for the storage circuit are investigated. Author (TAB)

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N68-33819# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
RANGE-GATED FILTER
Steven R. King Aug. 1968 57 p refs
(FSR-AD3-05-68.1)

The objective of this program was to develop a range-gated filter resolution element with a filter bandpass which could be discretely varied as a function of antenna pointing angle, and thereby maintain a relatively constant clutter attenuation. A back-up technique was also considered in the event a similar program employing field effect transistors (FETS), to continuously vary the filter frequency, proved to be unsuccessful. Results of this program indicate that this resolution element can be duplicated and microminiaturized to eventually create a full range coverage Moving Target Indicator (MTI) unit. A breadboard was tested, and performed as predicted both at room temperature and under environmental conditions. Author

N68-33896 Minnesota Univ., Minneapolis.
TRANSISTOR NOISE AT HIGH INJECTION LEVELS
Hu Tong (Ph.D. Thesis) 1967 87 p
Available from Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 67-14662

The theory of the shot noise in junction transistors has been well established. The noise in a transistor can always be represented by an equivalent e.m.f. e_s in series with the emitter junction and a current generator, i, in parallel with the collector junction. In general, e_s and i are partly correlated. In addition, there is thermal noise for the series resistance of the junctions. The most important thermal noise source being the base resistance. Hanson and van der Ziel introduce four noise parameters, which can be found calculating the equivalent noise resistance, Rn as a function of Rs, source resistance. Rn is plotted as a function of Rs and the curve is then fitted into equation. Experimental observations show that as far as the output current generator is concerned, the low-level injection theory seems to be valid at high currents, whereas other measurements indicate that the low-level theory is not valid at higher currents. The experimental frequency dependence of X_{sc} does not agree with the predictions of the low-level theory. Dissert. Abstr.

N68-33987 California Univ., Berkeley.
SHOT NOISE IN SPACE-CHARGE-LIMITED CROSSED-FIELD ELECTRON GUNS
Raymond Yue-chung Ho (Ph.D. Thesis) 1967 131 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-11632

The aim is to describe the effect of space charge on shot noise in crossed fields in a two-dimensional analysis and to determine the transition between the reduced shot noise in short guns and excess shot noise in long guns. A feedback model is employed because it can provide a relatively simple physical understanding of the complex shot noise phenomena. It is shown that when the cathode length is short compared with the cycloid length, the space-charge-limited shot noise is reduced below its temperature-limited level; and when the ratio of cathode length to cycloid length approaches 0.6, excess noise appears as a result of the potential minimum instability. Thus, it means that neither the transverse magnetic field nor the cathode length alone is responsible for the appearance of potential minimum instability or the excess noise. Moreover, it is evident that a change of transverse magnetic field is essentially the same as a change of cathode length. Dissert. Abstr.

N68-34011# Royal Aircraft Establishment, Farnborough (England).
INSERTION LOSS MEASUREMENT TO ASSESS THE PERFORMANCE OF A VHF/UHF SWITCHING DIODE
B. Lake Jan. 1968 22 p ref
(RAE-TR-68001) CFSTI: HC $3.00/MF $0.65

Insertion loss measurement has been used to assess the performance of a P.I.N. diode as a switch in the frequency range 100 MHz to 400 MHz. Values of insertion loss calculated from impedance measurements are compared with values obtained by direct measurement. Agreement is good for both forward and reverse bias. ESRO

N68-34012*# Gulton Industries, Inc., Hawthorne, Calif. Engineered Magnetics Div.
APPLIED RESEARCH AND FEASIBILITY STUDIES, EXPERIMENTAL INVESTIGATIONS AND CONCEPTUAL OR PRELIMINARY DESIGN ENGINEERING APPLICABLE TO INVERTERS FOR MOTORS PROGRAM Quarterly Progress Report, Period Ending June 25, 1968
D. B. Irvine 29 Jul. 1968 28 p
(Contract NAS8-20832)
(NASA-CR-61927; Rept.-2326; QPR-4) CFSTI: HC $3.00/MF $0.65 CSCL 09A

This report describes the accomplishments achieved during the period from March 26, 1968 to June 25, 1968. This report presents information pertaining to the design and evaluation of the inverter current sensing and limiting circuit and results obtained from inverter-motor system tests. Author

N68-34061# Royal Aircraft Establishment, Farnborough (England).
TRANSIENT AND STEADY STATE ANALYSIS OF INVERTOR SUPPLIED INDUCTION MOTORS
G. W. Wilcock Oct. 1967 46 p refs
(RAE-TR-67252) CFSTI: HC $3.00/MF $0.65

A method is presented of analyzing induction motors fed from non-sinusoidal voltage supplies such as static invertors. Two and three phase motors supplied by bridge invertors are analyzed and it is shown how the method can be used with other types of invertor and motor. Simple approximate formulae are developed for the starting mode. The performances of two different motors over a wide speed and supply frequency range are calculated and shown to be in good agreement with experiment. Results are calculated to show that a variable frequency invertor driven motor can generate torque efficiently and with low torque ripple over a wide speed range. Author (ESRO)

N68-34068*# Texas Instruments, Inc., Dallas. Components Group.
DEVELOPMENT OF A MICROELECTRONIC MODULE Interim Scientific Report, 1 Apr. 1967–31 Mar. 1968

H. Strack, F. Doerbeck, E. Harp, and E. Mehal Jun. 1968 93 p refs
(Contract NAS12-537)
(NASA-CR-86097; TI-03-68-26) CFSTI: HC $3.00/MF $0.65 CSCL 09A

GaAs NPN transistors were built using different kinds of crystal materials and different fabrication technologies. The electrical parameters of those devices were studied as a function of temperatures, and life-test experiments were performed. The best room-temperature transistors were made from (100)-oriented Tin-doped epitaxial slices. These devices had a current gain of about 100, low 25°C-leakage currents and a particularly low collector-emitter saturation voltage (0.15–0.25 V). The current gain of these devices, however, decreased immediately with raising temperature according to an activation energy of 0.2 eV. Successful high temperature transistors exhibit first an increase of current gain with increasing temperature, then a plateau at about 150°C, then a decreasing current gain, and finally following a 0.2 eV activation energy. The best high temperature transistors were fabricated from bulk GaAs material, grown in a sealed crystal puller, doped with silicon in the low 10^{16} cm^{-3} range. A double-oxide technique was used for those runs. These devices had low 25°C-current gain ($\approx$15) and an emitter-collector saturation voltage of about 1.5 volts. They were useful up to 340°C. A NAND-gate circuit using thick-film technology was built and tested. Circuits were operated at 300°C for 200 hours. They showed a degradation but still switched. Author

N68-34093# Kiel Univ. (West Germany). Inst. für Reine und Angewandte Kernphysik.
PHOTOTUBE HIGH-VOLTAGE SUPPLY FOR EXPERIMENTS WITH BALLOONS, ROCKETS AND SATELLITES [SPANNUNGSVERSORGUNG FUR PHOTOMULTIPLIER BEI EXPERIMENTEN MIT BALLONEN, RAKETEN UND SATELLITEN]
G. Wibberenz and H. Kunow Apr. 1968 100 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung (BMWF-FBW-68-24) CFSTI: HC $3.00/MF $0.65

A high-voltage dc-dc converter for phototubes has been developed for space applications by using a modified Greinacher cascade. Special emphasis was on low power consumption even under extreme fluctuations of the photomultiplier current. A 100 kHz wave generator transforms a 12 V d-c voltage into a trapezoidal 100 kHz oscillation of 45 V amplitude, which is then rectified and multiplied. The equidistant filtered d-c voltages are directly fed to the phototube dynodes. The constancy of these voltages is ±0.15% for fluctuations of the battery voltage and changes of the phototube on the last dynode-anode section between 0 and 50 μA. Several versions of the converter are described and analyzed theoretically. They differ in temperature response and mechanical design. The last version has a temperature coefficient of $-5 \cdot 10^{-5}$/°C between −40 and +60°C. The power consumption is around 160 mW for a total phototube voltage of 1000 Volt, the unit weighs 130 g after potting. The converters have been vibration and vacuum tested and were sucessfully used in several balloon and rocket experiments. Author (ESRO)

N68-34161# Fluggerätewerk Bodensee G.m.b.H., Uberlingen (West Germany).
INVESTIGATION OF INTERAXES COUPLING AND SIMULATION OF THE DYNAMICAL BEHAVIOR OF A STABILIZED PLATFORM BY ANALOG COMPUTER [UNTERSUCHUNG UBER DIE AUSWIRKUNG DER KOPPLUNGEN ZWISCHEN DEN KREISEN ZUR STABILISIERUNG EINER PLATTFORM UND SIMULATION DES DYNAMISCHEN VERHALTENS EINER KREISELSTABILISIERTEN PLATTFORM AUF DEM ANALOGRECHNER]
U. Krogmann May 1968 67 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMWF-FBW-68-35) CFSTI: HC $3.00/MF $0.65

Starting with the transfer function of a single degree of freedom rate integrating gyro and taking into account rotation of the gyro case about its output axis, the coupling terms between the platform axes are determined. The characteristic equation of the system with interaxes coupling is derived and discussed, and the conditions for minimum coupling effect stated. Final simulation of the complete system shows that interaxes coupling does not affect the dynamic behavior of the platform considerably; even when nonlinearities are considered within the loops. Author (ESRO)

N68-34169# Centre National de la Recherche Scientifique, Marseilles (France). Laboratoire d'Astronomie Spatiale.
PULSE COUNTING MEASUREMENTS OF THE RESPONSE OF A PHOTOMULTIPLIER [MESURE PAR COMPTAGE D'IMPULSIONS DE LA RESPONSE DONNEE PAR UN PHOTOMULTIPLICATEUR]
E. Rodier, A. Roussin, and G. Gonczi *In its* Summer School, Strasbourg, 3–7 Jul. 1967 14 p refs In FRENCH (See N68-34168 21-23)

The characteristics of photomultipliers are recalled and disadvantages of measurements by means of electrometers are analyzed. A new method of data processing using photometers is presented and discussed. ESRO

N68-34253*# Radio Corp. of America, Somerville, N. J. Defense Microelectronics.
THICK FILM ACTIVE DEVICES Final Report
W. Lsznovsky Jun. 1968 48 p refs
(Contract NAS1-7340)
(NASA-CR-66869) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The potential of randomly oriented screen-printed CdS layers as a basis for insulated gate field effect transistors was established. The application of these layers in an all screened thick film transistor has had little success (very low gm and drain currents were obtained). The principal difficulties were surface layer roughness, and contamination of the channel region by electrode and dielectric layers during sintering. A detailed analysis of these difficulties was made. Studies in screen printing dimensional control resulted in the development of a new precision press capable of depositing channel lengths of the order of 1 mil. Author

N68-34351# Gulf General Atomic, San Diego, Calif.
MECHANISMS OF TRANSIENT RADIATION EFFECTS
V. A. J. van Lint 28 Aug. 1968 68 p refs
(GA-8810)

The effects of irradiating nuclear particles on electronic components and devices are studied. Collisions between incident nuclear particles and atoms located in crystalline lattices result in displacement of the struck atom from its usual lattice site; thus, the property of minority carrier lifetime in semiconductors is rapidly changed. Free electrons and ions produced in radiative interactions primarily increase the conductivity. As associated ionization effect is the transfer of charge in circuit elements and the creation of electric and magnetic fields within cavities and insulators. Changes in electrical properties caused by the rearrangement of chemical bonds are insignificant. G.G.

N68-34365 European Organization for Nuclear Research, Geneva (Switzerland).
ON THE DESIGN OF DISC-LOADED WAVEGUIDES FOR RF SEPARATORS
D. Bernard, H. Lengeler, and V. Vaghin (Inst. of High Energy Phys., Serpukhov, USSR) 22 Jul. 1968 42 p refs
(CERN-68-30)

Some aspects of the deflecting hybrid mode in disc-loaded waveguides are considered. From power tests in CERN deflectors (λ = 10.5 cm) the absolute value of E_p is found to be 522 kV/cm

at a pulse duration $\tau = 1$ μsec. It turned out that the locations of the break-downs on the disc surface coincide with the points corresponding to the location of E_p as determined from cold measurements. For the dependence of the values E_p and P_p on the pulse duration a law $E_p \approx \tau^{-1/4}$ and $P_p \approx \tau^{-1/2}$ is found. Since at present the E_p/E_0 parameter cannot be calculated, a method of measurement was developed and is described. The results of these measurements for the modes $\pi/2$, $2\pi/3$ and $4\pi/5$ with different disc thickness are presented in a systematic form. On the basis of these results the estimation of the limiting power for the modes $\pi/2$, $2\pi/3$ and $4\pi/5$ with different disc thickness is made. A scheme of optimization of the deflector parameters is outlined and applied to the CERN RF beam. The optimized parameters for the new CERN deflectors are given and compared with the old ones. Author

N68-34396# Zenith Radio Research Corp., Menlo Park, Calif.
TRANSVERSE-WAVE HIGH-POWER TUBE Final Report, 1 Jan. 1967–2 Feb. 1968
C. Burton Crumly Jun. 1968 37 p
(Contract DAAB07-67-C-0226)
(ECOM-0226-F; AD-672088)

Research and development work is described on a power amplifier tube employing transverse-wave interaction between the negative synchronous wave and a traveling circuit wave on a balanced structure. The theoretical advantage in this arrangement is the possibility of high-power amplification with high overall efficiency, due to the lack of longitudinal or transverse velocity modulation in the spent beam. The initial design parameters are reviewed, and modifications are discussed. The design and fabrication of the attenuator is outlined, and measured results presented. Modifications to the waveguide input and output sections, and to the vacuum windows, are described. Author (TAB)

N68-34407# Los Alamos Scientific Lab., N. Mex.
EIGHTY KILOVOLT BLOCKING OSCILLATOR MODULATOR
J. D. Doss, R. L. Cady, D. C. Hagerman, and T. F. Turner [1968] 12 p Presented at 10th Modulator Symp., New York
(Contract W-7405-ENG-36)
(LA-DC-9478; CONF-680520-1) CFSTI: HC$3.00/MF$0.65

The Los Alamos Meson Physics Facility will use approximately 44 klystrons in the 805–MHz waveguide section of the linac. Pulse width and repetition rate will be 1 msec and 120 Hz respectively. Each klystron will be capable of delivering 1.25–MW peak power output at 12% DF. These klystrons are equipped with a modulating anode that must be switched from cathode potential to approximately body potential to turn the beam on. The peak voltage swing required from the modulator is about 80 kV with a load current of a few milliamperes to the modulating anode and 1.0 ampere to a parallel resistive load. The switch tube used for this modulator is a Machlett ML–7248 tetrode. The blocking-oscillator regenerative modulator is examined in detail. NSA

N68-34437# Los Alamos Scientific Lab., N. Mex.
FAULT PROTECTION CIRCUITRY FOR THE LASL 201.25-MHZ POWER AMPLIFIERS
J. D. Doss [1968] 8 p Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y.
(LA-DC-9446; CONF-680515-5) CFSTI: HC$3.00/MF$0.65

Circuits are presented to protect the rf power amplifiers for the linear accelerator from such faults as high anode currents and rf arcs. The anode-current detector consists of a Schmitt-trigger type circuit that generates an output to inhibit the pulse gate whenever anode current exceeds 25 percent of its normal maximum load. A modulator grid-clamp circuit is used to solve the problem of negative grid current. Crowbar circuitry is used to protect aganist arcing, amplitude faults, and pulse width faults. NSA

N68-34447# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LOW-NOISE ULTRAHIGH-FREQUENCY (UHF) AMPLIFIERS
M. S. Shutenko 5 Dec. 1967 137 p refs Transl. into ENGLISH of the book "Maloshumyashchiye Usiliteli Svch" Moscow, 1966 p 1–151
(FTD-HT-23-1178-67; AD-672334)

The book discusses the physical bases and principles of operation of the low-noise UHF amplifiers. These amplifiers appeared as a result of the latest achievements of physics and radioelectronics, and presently are finding an ever-increasing application. The introduction of low-noise amplifiers in the receiving systems of military technology, communication facilities (for example, with artificial earth satellites) instruments used in radio astronomy, etc., have markedly increased the potentialities of the equipment. Author (TAB)

N68-34458# Varian Associates, Palo Alto, Calif.
A DEVELOPMENT PROGRAM TO IMPROVE BROADBANDING OF HIGH POWER AMPLIFIER KLYSTRONS Quarterly Report, 1 Jan.–31 Mar. 1968
L. Zitelli May 1968 17 p
(Contract DAAB07-68-C-0080)
(VARIAN-357-2Q; QR-2; AD-672508)

It appears that existing computer programs will accurately predict the bandwidths and gains of klystron amplifiers designed for rather wide (2%) electronic bandwidths. Further, it appears that ordinary filter theory is satisfactory for predicting the output circuits characteristics. With these two capabilities in hand, it is clear that one can do a good job of designing various broadband klystron amplifiers on paper. An 8-kW cw klystron amplifier was designed to operate at 8 GHz with an electronic bandwidth of 150 MHz, an efficiency greater than 35% and a drive power requirement of less than 3 watts. Author (TAB)

N68-34484# Army Electronics Labs., Fort Monmouth, N. J.
WAVE PROPAGATION ON HOLLOW ELECTRON BEAMS IN FINITE MAGNETIC FIELDS
Bruno Zotter Jun. 1968 33 p refs
(ECOM-2980; AD-672065)

Hollow electron beams find wide use in modern microwave tubes. The wave propagation on such beams, focused by finite magnetic fields, is studied under small-signal conditions. The dispersion relation for slow waves is derived, and numerical solutions are presented in graphical form. Two types of axisymmetric modes can exist on a hollow beam, which are called space-charge and vortex modes. The radial propagation constant and the plasma frequency reduction factor are shown for a number of typical cases. A brillouin diagram is given for a beam of perveance 5 microperv. Comparison is made with results of earlier publications which use the finite field approximation. Author (TAB)

N68-34509# Los Alamos Scientific Lab., N. Mex.
805-MHZ POWER SOURCES FOR THE LAMPF ACCELERATOR
D. C. Hagerman 1968 10 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y. Sponsored by AEC
(LA-DC-9444; CONF-680515-10) CFSTI: HC$3.00/MF$0.65

Triodes, crossed-field amplifiers, and klystrons were tested, and the klystron was chosen to be used as the 805-MHz power source for the LAMPF System specifications and design studies are discussed. NSA

N68-34552# Brookhaven National Lab., Upton, N. Y.
OPTIMIZATION OF ALTERNATING-PERIODIC IRIS-LOADED DEFLECTORS FOR SUPERCONDUCTING RF BEAM SEPARATORS

H. Hahn [1967] 12 p refs
(BNL-12536; CONF-680515-3) CFSTI: HC$3.00/MF$0.65

Analytical expressions for transverse shunt impedance, peak fields, group velocity, etc., of alternating-periodic iris-loaded deflector cavities operating in the confluent $\pi/2$ mode are derived from the TM_{11}-like small-pitch approximation. It is shown that the smallest peak fields and the largest shunt impedance are obtained in structures with vanishingly small width of the coupling cell. An optimization of the structure determines the ratio of the beam hole radius divided by the wavelength to be 0.3, implying a forward-wave operation. Possible complications due to the degenerate dispersion diagram are discussed. Author (NSA)

N68-34605# Raytheon Co., Waltham, Mass. Research Div.
CHEMICAL VAPOR DEPOSITED MATERIALS FOR ELECTRON TUBES Triannual Report, 15 Dec. 1967–14 Apr. 1968
S. R. Steele, H. Schilling, J. Pappis, and J. Simpson Jun. 1968 54 p refs
(Contract DAAB07-68-C-0156)
(S-1075; ECOM-0156-1; Rept.-1; AD-672095)

Microwave tests of etched patterns of a conductor on a dielectric substrate have shown that fine-lined, ruled structures can provide slow-wave circuits of the Karpline type when the assembly is uniform over its length. Tests have shown that grid spacers can easily be made of high-density isotropic CVD BN by using an air abrasive unit. Several isotropic CVD BN depositions to fabricate cylindrical microwave windows were made with uniformly good results. Isotropic CVD BN materials with densities both higher and lower than standard isotropic CVD BN were prepared in small quantities. Preliminary measurements have shown that certain of these materials may be more desirable for some applications than standard isotropic CVD BN. High-density isotropic CVD BN can be prepared by reducing reactant concentrations but the deposition rate is low. Increased density, together with increased deposition rate, appears possible with proper control of critical deposition parameters. Good results were obtained with a special metallizing tape (88% ZrH_2-12% Ni) on boron nitride, but since the air prefiring is critical, this tape technique may be abandoned. Author (TAB)

N68-34607# Brookhaven National Lab., Upton, N. Y.
DISCUSSION OF H.V. POWER SUPPLY UNITS CONNECTED WITH HIGH GRADIENT TUBES IN LINAC PREINJECTORS
V. J. Kovarik and Th. J. M. Sluyters [1968] 21 p ref Presented at Conf. on Proton Linear Accelerators, Upton, N. Y. Supported in part by AEC
(BNL-12570) CFSTI: HC$3.00/MF$0.65

In the new accelerating tubes of preinjectors, the gradients (30–50 kV/cm) are significantly larger than in conventional tubes inside the vacuum by electric field emission, increase rapidly with the field strength. A sudden large increase of current, known as a vacuum breakdown or discharge, damages the electrodes, thereby triggering other breakdowns. In the arrangement of high voltage power supplies for high gradient tubes, it is essential to reduce the current in such a discharge. This can be realized by a surge resistor in series with a reduced filter capacitor. However, this influences the beam loading characteristics and consequently the circuit (called the "bouncer") that compensates for it. The selection of the surge resistor in an open 750 kV circuit and its consequences in possible "bouncer" systems are discussed. The characteristics of the 850 kV Haefely Cockcroft-Walton are considered. Author (NSA)

N68-34651# Naval Research Lab., Washington, D. C.
A SUBSATELLITE AREA-OF-VIEW CIRCUIT Interim Report
R. J. Orsino and H. G. Talmadge, Jr. Apr. 1968 43 p
(NRL-6660; AD-672316)

A subsatellite circle circuit is included in the NRL experimental satellite position prediction and display equipment (SPAD). The circuit paints, on the expanded display, a circle enclosing the area of view for a selected satellite. A combination of digital and analog techniques is used to generate a polygonal approximation to the ideal circle. Compensation for meridian convergence is provided, so that the resulting error is roughly equal to the degree to which an octagon approximates a circle. With simple circuit changes the polygon could have 12, 16, 20, or more sides. The circle center is defined by the subsatellite position, and the SPAD prediction computer uses the satellite look-cone angle (say, that of a cloud-cover camera) and the satellite height to generate a circle radius in increments of 8 naut mi up to a maximum radius of 504 naut mi. This limit is determined by the practical requirement of displaying the circle only on the expanded display of limited area for any portion of the earths surface. A duplicate circuit generates a circle about own ships position. The operational significance to be attached to the circles is of no concern in the present study. Rather, the circuit design approach, the design equations, and circuit description at the block-diagram level are the important elements. With suitable modification the circle circuit used for SPAD is applicable to any cathode-ray tube display having either electrostatic or magnetic deflection, providing the entire display surface is scanned by a method involving two orthogonal axes of deflection. Author (TAB)

N68-34693*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AN INTEGRABLE IF AMPLIFIER OF HIGH STABILITY
W. J. Kerwin and Charles V. Shaffer (Fla. Univ.) [1968] 11 p refs Presented at the 11th Midwest Symp. on Circuit Theory, Notre Dame Univ., 13–14 May 1968
(NASA-TM-X-61235) CFSTI: HC$3.00/MF$0.65 CSCL 09A

Details are given on the use of right-half-plane, complex-phantom zeros to achieve a significant gain reduction for a given pole Q, thereby increasing the high frequency capability without greatly increasing the Q sensitivity. Network realizations are shown for both lumped and distributed RC networks. Design equations are given for the lumped element case and design charts for the distributed case. Plots of the gain required for a given Q, of the Q sensitivity to gain change and the frequency of maximum response as a function of the real part of the right-half-plane phantom zero position complete the design data. Author

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N68-33650*# Honeywell, Inc., St. Paul, Minn. Systems and Research Div.
APPLICATION OF OPTIMAL CONTROL THEORY TO LAUNCH VEHICLES Final Technical Report
C. A. Harvey Jul. 1968 155 p refs
(Contract NAS8-21063)
(NASA-CR-61939; Rept.-12073-FR1) CFSTI: HC $3.00/MF $0.65 CSCL 09C

This report is a technical summary of an investigation of the application of optimal control theory to the design of launch vehicle control systems. The goal of this study was the development of a practical design technology based on optimization theory for launch vehicle attitude control systems. The development of a practical design technology requires the development of a method for simplifying the optimal controller produced by the optimization theory. For a practical controller this simplification technique must

yield a controller which uses a practical sensor complement. Thus, a method for choosing a set of feedback sensors and sensor locations for the simplified controller must be developed concurrently with the simplification technique. The attempts to develop such techniques are described following descriptions of the mathematical model employed in the study and the formulation of the optimization problem. The experimentation is described followed by a description of a simplified controller designed on the basis of results from the series of experiments. Quantitative results obtained during the course of the investigation are presented, followed by general conclusions and recommendations for further study. Author

N68-33685*# Santa Clara Univ., Calif.
PARAMETER PLANE ANALYSIS OF FORCED NONLINEAR OSCILLATIONS
D. Siljak and J. Moore (Newcastle Univ., Australia) [1967] 27 p refs Presented at the 4th Allerton Conf. on Circuit and System Theory, Monticello, Ill., 5–7 Oct. 1966 Submitted for publication
(Grant NGR-05-017-010)
(NASA-CR-89189) CFSTI: HC $3.00/MF $0.65 CSCL 09C

This paper presents an application of the parameter plane method to the analysis of forced oscillations and jump-resonance phenomena in nonlinear systems subject to periodic forcing signals. The approximate analysis procedure utilizes the describing function technique. The advantage of the procedure lies in the fact that only one parameter plane diagram is necessary to investigate the effects of different forcing signals. If the amplitude of the forcing function is fixed, a modification of the proposed procedure enables an analysis of the jump-resonance phenomena for different non-linear characteristics. The stability and sensitivity of forced nonlinear oscillations are also discussed. The procedure is illustrated by examples. Author

N68-33700 Minnesota Univ., Minneapolis.
SPACE CHARGE LIMITED CURRENT IN GAS DIODES
Charles Bruce Johnson (Ph.D. Thesis) 1967 102 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-16251

The literature on this subject is discussed and a theory is presented for gas diodes, i.e., diodes in which the electronic mean free path is much smaller than the interelectrode spacing, under space charge limited conditions. Current-voltage relations are derived for diodes having plane-parallel, circular-cylindrical, and spherical symmetry. Experimental results were acquired using a cylindrical gas diode. Theoretical current-voltage curves were obtained using helium, neon, argon, and nitrogen gases and compared to the measured characteristics. The results indicate that the observed and predicted characteristics are in good agreement with respect to the curve shapes. Excellent current magnitude correspondence is obtained in helium, although the values of current magnitude do not always correspond exactly for the other gases. Dissert. Abstr.

N68-33734*# Buenos Aires Univ. (Argentina).
CONTROLABILITY OF HIGHER ORDER LINEAR SYSTEMS
H. O. Fattorini [1967] 14 p refs Presented at the Conf. on the Mathematical Theory of Control, Los Angeles, 30 Jan.–1 Feb. 1967
(Grants NGR-40-002-015; AF-AFOSR-693-66)
(NASA-CR-83444) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A dynamical system is considered whose evolution in time is described by a second order linear differential equation in a complex Banach space $E = u, v, \ldots u''(t) = Au(t) + Bf(t)$, where A is a linear, possibly unbounded operator with domain $D(A) \subset E$ and range in E, B a bounded operator from another Banach space F to E. Some results obtained on the theory of this equation are applied to show that the problem of complete controllability of such a system can be reduced to the corresponding one for the first order system $u' = Au + Bf$ if A satisfies a certain condition. The relation between null and complete controllability is examined for first and second order systems. K.W.

N68-33738*# Arizona Univ., Tucson. Dept. of Electrical Engineering.
AN ANNOTATED BIBLIOGRAPHY FOR DISTRIBUTED RC NETWORKS
S. P. Johnson and L. P. Huelsman Sep. 1968 16 p refs
(Grant NGL-03-005-136)
(NASA-CR-96548) CFSTI: HC $3.00/MF $0.65 CSCL 09C

This bibliography contains a listing, arranged in alphabetical order, of the papers which have appeared in the electrical engineering literature pertinent to the subject of distributed RC networks. A short summary of the content of each paper follows the bibliographic data. Author

N68-33740 California Univ., Berkeley.
CONSTANT-RESISTANCE NETWORKS WITH NONLINEAR AND TIME-VARYING ELEMENTS
Kenneth Kin-Hei Wong (Ph.D. Thesis) 1967 100 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-11679

This thesis is concerned with constant-resistance networks with nonlinear and time-varying elements. The main ideas of the thesis are divided into four parts. Methods for generating constant-resistance networks with nonlinear, time-varying elements are proposed. It is proved that the basic Norton's high-pass low-pass complementary constant-resistance networks can have linear elements only. The conditions under which a self-dual network is constant resistance are given; furthermore, examples of self-dual constant-resistance networks constructed from arbitrary one-ports and their duals are discussed. The applications of these constant-resistance networks is considered. The focus is on the use of nonlinear networks as variable-parameter small-signal linear networks through change of operating points. Dissert. Abstr.

N68-33750 Cincinnati Univ., Ohio.
THE MATHEMATICAL FOUNDATION OF KRON'S TENSOR ANALYSIS OF ELECTRICAL NETWORKS
Kuo Un. Wang (Ph.D. Thesis) 1967 109 p
Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-15978

Kron's orthogonal networks and methods of tearing are given a rigorous mathematical foundation through general Kron–Roth 1-network theory developed in the thesis. The direct sum decomposition of 1-chain space (group) C_1 into 1-cycle space Z_1 and the quotient space C_1/Z_1 and the exact sequences formed by these vector spaces constitute the basic concepts of 1-network theory. A comparison with linear graph theory of electrical networks is made. The mathematical basis for algebraic synthesis of circuits by impedance technique is also included. Dissert. Abstr.

N68-33767*# Hughes Aircraft Co., Fullerton, Calif.
TRANSISTOR DESIGN EFFECTS ON RADIATION RESISTANCE
C. C. Berggren and V. R. Honnold Washington NASA Sep. 1968 97 p refs
(Contract NAS1-6954)
(NASA-CR-1167) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Analytical expressions relating transistor design parameters to radiation induced gain degradation were developed. Emitter efficiency and base transport injection level effects have received prime consideration. Several statistically designed experiments, which employed custom designed planar transistor variations, were

conducted to evaluate the theoretical conclusions. The need for accurate profile information, to correlate with radiation induced gain degradation, is established. Shallow junctions and low base doping are shown to contribute significantly to radiation resistance.
Author

N68-33837*# California Univ., Berkeley. Electronics Research Lab.
CONSTRAINED MINIMIZATION UNDER VECTOR-VALUED CRITERIA IN LINEAR TOPOLOGICAL SPACES
N. O. Da Cunha (Tech. Inst. of Aeron., Sao Paulo, Brazil) and E. Polak [1967] 13 p refs Presented at the Math. Theory of Control Conf., Univ. of Southern Calif., 30 Jan.–1 Feb. 1967 Submitted for publication
(Grant NsG-354)
(NASA-CR-85133) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Some of the necessary conditions and theorems on scalarization, i.e., the conversion of the problem into a family of optimization problems with a scalar criterion, for problems defined in R^n are extended to linear topological spaces. The derivation of the necessary conditions follows a well-known optimization procedure. The emphasis is on scalarization by weighting the components of the vector cost with strictly positive coefficients into a real valued function.
K.W.

N68-33873 Utah Univ., Salt Lake City.
SYNTHESIS OF FILTERS USING FEEDBACK-CIRCUIT MODULES
William Leroy Hill Jones (Ph.D. Thesis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-12204

The characteristics of two-pole and three-pole feedback circuits which consist of one unity-gain amplifier and a resistance-capacitance feedback network are examined in detail to determine whether they may be designed as isolated units or modules and cascaded to synthesize higher-order filters. A two-port admittance-parameter matrix is obtained for each module and for cascaded modules. It is shown that if an ideal unity-gain amplifier is used in each module the two-pole module, the three-pole module and cascaded modules have isolation properties characterized by a reverse transfer admittance less than 10^{-4} mhos in the worst case. Thus it is predicted that each module may be designed as an isolated unit and that any number of modules may be cascaded to synthesize filters having high cut-off rates. Dissert. Abstr.

N68-33944 Columbia Univ., New York.
NUMERICAL SOLUTION OF DISTRIBUTED NETWORKS CONTAINING NON-LINEAR ELEMENTS
Michael Silverberg (Ph.D. Thesis) 1967 102 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-12277

The method is based on partitioning a network so that on one side there are only linear, fixed elements; on the other side, nonlinear and time-varying elements. Terminal characteristics are obtained for the linear part in the frequency domain and converted to time domain data by numerical Laplace transform inversion. The overall network is then solved in the time domain using convolution techniques. This procedure may be interpreted as finding a lumped, time-varying terminal equivalent of a distributed system. The overall lumped equivalent network may then be solved by conventional methods of integration of ordinary differential equations. An improved version of the Cooley–Tukey algorithm is described which is efficient where the inverse transform is desired at uniformly spaced points. These methods are applied to problems of integrated circuits using both lumped and distributed transistor models. Dissert. Abstr.

N68-33955 Arizona State Univ., Tempe.
MINIMAL RESPONSE TIME BOUNDED VARIABLE CONTROL
John Tartar (Ph.D. Thesis) 1967 83 p
Available from Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-12657

In many problems of process control, it is desired to reduce the system error, introduced by transient inputs or random disturbances, to some minimum value in the shortest possible time. In these physical processes, it is considered that the input and the controlled variables have maximum bounds and that the controller be digital in nature. This investigation presents a method for the determination of minimal response time control of linear processes. The integral of squared error plus the time the error is different from zero is chosen as a mathematically tractable performance index. A discrete analog of the continuous process, developed from a consideration of the digital controller, is used to define the proper control within independent sequences of time. The system is treated as an infinite stage optimization process with the control decisions being made at each step to minimize the chosen performance index. Dissert. Abstr.

N68-33974 Iowa State Univ. of Science and Technology, Ames.
CRITERIA FOR DEGREE OF OBSERVABILITY IN A CONTROL SYSTEM
Henry Louis Ablin (Ph.D. Thesis) 1967 77 p
Available from Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-12939

This work expands on the overall system criterion and develops two new criteria which are measures of how observable each of the state-variables are. All of the criteria developed are based on the Q matrix of the state-variable system. The overall system criterion turns out to be the smallest eigenvalue and its associated eigenvector of the $Q_N Q_N^T$ matrix. The other criteria were developed because the overall system criterion does not yield the same insight for a complicated system as it does for a simple system. These criteria are called degree of observability per state-variable; one is based on standard deviation error analysis and the other is based on upper bound error analysis. Two inertial navigation systems were used as examples to illustrate these criteria. The criteria developed in this investigation should be useful to the design engineer as a means of gaining insight into the system. Dissert. Abstr.

N68-33998 Rice Univ., Houston, Tex.
TIME OPTIMAL CONTROL OF LINEAR DISTRIBUTED PARAMETER SYSTEMS
Kaushik P. Sriram (Ph.D. Thesis) 1967 64 p
Available from Univ. Microfilms: HC $3.60/Microfilm $3.00 Order No. 67-13126

The applicability of the Laplace transformation for the determination of the time optimal control of two typical distributed parameter systems with amplitude constraints on the control is demonstrated. The method— which can be interpreted as requiring a control whose transform in combination with the initial conditions places zeroes at the poles of the open loop transfer function— is used to derive the time optimal control for a linear diffusion process, as a typical example of a system described by a parabolic partial differential equation, on the assumption that it is bang-bang, i.e., it is always as its limiting values. To demonstrate the effect which the nature of the partial differential equation has on the form of the optimal control, the problem of wave propagation on a transmission line (which is governed by a hyperbolic partial differential equation) is considered. Dissert. Abstr.

N68-34002 Denver Univ., Colo.
THE GENERATION OF LIAPUNOV FUNCTIONS IN AUTOMATIC CONTROL THEORY BY AN ENERGY METRIC ALGORITHM
Edward Thomas Wall (Ph.D. Thesis) 1967 135 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-16607

An algorithm for the generation of Laipunov functions in nonlinear automatic control theory is described. The procedure which is referred to as the energy metric algorithm permits the generation of Liapunov functions directly from the control system equations, without the use of a quasi-linearization procedure. The algorithm is limited to a system which can be represented by an autonomous nonlinear differential equation of the form $\dot{x} = F(x)$, $F(0) = 0$. The approach to the problem of generating a scalar function V(x) to satisfy a particular Liapunov theroem is to extend the total energy of a system by use of the line integral of a composite differential one-form derived directly from the system equations. Then, if the total derivative with respect to time is at least negative semidefinite, the V(x) function is a Liapunov function. The mathematical form of a conservative system is used as a structural analog for the algorithm. Dissert. Abstr.

N68-34039 Arizona State Univ., Tempe.
A DISTRIBUTIONAL APPROACH TO THE TIME DOMAIN ANALYSIS OF LINEAR SYSTEMS
Jon William Bayless (Ph.D. Thesis) 1967 98 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-12636

A new approach to the time domain analysis of linear systems is presented. This approach is developed using the mathematical theory of distributions by interpreting the system input-output relationship as a distributional equation. Two fundamental solutions are developed for the system output. Fundamental solution I gives the total system response to a piecewise continuous input. Fundamental solution II gives the steady-state system response to a periodic input. Applications of the fundamental solutions to causal and noncausal linear systems are presented. Using distributional formulation, a new approach is developed to the problem of frequency modulation distortion in bandpass filters. The Fredholm integral equation of the first kind occurs frequently in theory of signal detection and filtering. A new approach to the solution of this equation is developed by interpreting it as a special case of distributional convolution. Dissert. Abstr.

N68-34151# Royal Aircraft Establishment, Farnborough, (England).
TWO CONTRIBUTIONS TO REDUNDANCY THEORY
Theresa F. Klaschka Dec. 1967 23 p refs
(RAE-TR-67306) CFSTI: HC $3.00/MF $0.65

By analysing an ideal model of a redundancy scheme, a measure for the reliability improvement produced by a redundancy scheme is found; and it is shown that for real redundancy schemes this measure is effectively independent of the size of system to which the scheme is applied. Other advantages of the measure are that it is relatively easy to evaluate, and has a good sensitivity characteristic. This measure, together with a redundancy cost factor, represents the performance of a redundancy scheme more generally than was previously possible. A new high performance redundancy scheme—radial logic is described, and its error correcting action explained. It can be applied to combinational and sequential logic circuitry, and in this application appears to have a better performance than other schemes, as well as being simple to design, and offering considerable flexibility in the degree of error correction. Author

N68-34182 Lehigh Univ., Bethlehem, Pa.
THEORY AND DESIGN PRINCIPLES OF THE MONOLITHIC CRYSTAL FILTER
William Dean Beaver (Ph.D. Thesis) 1967 172 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-14929

The monolithic crystal filter consists of a quartz crystal plate with an array of two or more electrode pairs placed on its major surfaces and with each pair establishing a resonator system. The resonators are acoustically coupled via the elastic quartz plate. This dissertation presents an analysis of experimental results relating the inter-resonator coupling to the electrode dimensions. These results lead to the establishment of an equivalent electrical network for the coupled resonator system and equations are derived relating the electrical elements in this network to the geometry of the electrode configuration. The image impedance of the lattice equivalent of the two resonator filter is calculated and the factors making possible the band pass filter characteristics of the device are discussed. A theoretical analysis of the piezoelectric system representing the monolithic crystal filter is presented. Dissert. Abstr.

N68-34203* Santa Clara Univ., Calif.
PARAMETER ANALYSIS OF LINEAR TIME-VARYING SYSTEMS
R. Bittel (ESL, Sunnyvale, Calif.) and D. Siljak [1968] 11 p refs Presented at the 5th Allerton Conf. on Circuit and System Theory, Urbana, Ill., 3–6 Oct. 1967 Submitted for Publication
(Grant NGR-05-017-010)
(NASA-CR-88188) CSCL 09C

The paper presents a technique for predicting the transient responses of linear time-varying systems where the parameters vary as functions of time. The technique is based upon an extension of the Krylov–Bogoliubov method and the parameter plane analysis. It enables a deliberately introduced time-varying parameter to improve the system response. Computer simulation results are given to indicate the accuracy of the presented technique and its value as a design aid. Author

N68-34386*# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.
A METHOD FOR OBTAINING DESIRES SENSITIVITY CHARACTERISTICS WITH OPTIMAL CONTROLS
Charles F. Price and John J. Deyst, Jr. Jan. 1968 19 p refs Presented at the Joint Autom. Control Conf., Ann Arbor, Mich., 26–28 Jun. 1968
(Grant NGR-22-009-207)
(NASA-CR-96820; RE-37) CFSTI: HC $3.00/MF $0.65 CSCL 09C

An approach is offered to the problem of designing feedback optimal controls to minimize the effects of parameter variations on system performance. It is found that the optimal control can be expressed as a linear function of the state. The resulting design is superior, from the standpoint of trajectory sensitivity, to systems whose controls depend explicitly only upon the time. The solution of an example problem is included. Author

N68-34394*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
OPTIMAL CONTROL OF SATELLITE ATTITUDE ACQUISITION BY A RANDOM SEARCH ON A HYBRID COMPUTER
William P. Kavanaugh, Elwood C. Stewart, and David H. Brocker [1968] 41 p refs Presented at the Spring Joint Computer Conf., Atlantic City, 30 Apr.–2 May 1968
(NASA-TM-X-61197) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Control problems may be formulated in seeking the global minimum of a performance surface. Generally, the equations of this surface are unknown; further, the surface is often discontinuous, and has many peaks, valleys, and flat regions. Random search techniques are most appropriate in treating such problems. An

adaptive random search algorithm was developed earlier and applied to the minimum of of seeking the minimum of a boundary surface associated with the two-point boundary-value problem that results from an application of the Maximum Principle. The algorithm was reviewed and applied to a more complex problem: the minimum-fuel, large-angle, single-axis attitude acquisition problem. Comparison to optimal proportional control shows striking improvement in performance. Cross sections through the boundary surfaces reveal many of the irregularities noted above. Author

N68-34423*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE TRANSFER FUNCTION APPROACH TO SENSITIVITY ANALYSIS BY DIGITAL COMPUTER
Robert M. Muñoz and S. Park Chan [1968] 12 p refs Presented at the 11th Midwest Conf. on Circuit Theory, Notre Dame, Ind., 13–14 May 1968
(NASA-TM-X-61193) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The problem of computing sensitivities for any arbitrary system is discussed. A mathematical development using the theory of signal flow graphs proves in a relatively simple way that sensitivity can be computed as the product of certain transfer functions derived from the system in question. This allows the use of general purpose transfer function computer analysis programs and reduces the problem of sensitivity to one that has already been solved. Further developments in extension of this theory to the general case of root sensitivity should be fruitful. Author

N68-34497# Illinois Univ., Urbana. Coordinated Science Lab.
USE OF SWITCH SENSITIVITIES TO PROVIDE NEAR OPTIMAL CONTROL
R. G. Stefanek and J. Cruz Jun. 1968 16 p refs
(Contract DAAB-07-67-C-0199; Grant AF AFOSR-931-67)
(R-384; AD-672486)

The paper presents a method of control that is near optimum in the presence of small variations of the initial state. The method is demonstrated by considering the problem of fixed-time fuel optimization of a linear system with a bounded control. The control law is implemented using stored data about the nominal control and changes in the optimal switch times due to changes in parameters. Sampling of the state of the system before the first switch time is used to determine the perturbed initial states. A third order example is presented. Author (TAB)

N68-34514# Naval Avionics Facility, Indianapolis, Ind.
DIGITAL INTEGRATED CIRCUIT COMPATIBILITY STUDY
Leo F. Welsh 1 Apr. 1968 56 p
(NAFI-TR-1093; AD-672183)

The report describes a series of tests which were conducted on integrated digital logic devices from seven manufacturers. Examined in this report are NAND gates and flip-flops, and the capability of mixing different brands and different types of logic within the same system. Author (TAB)

N68-34520*# California Univ., Berkeley.
ON THE REMOVAL OF ILL CONDITIONING EFFECTS IN THE COMPUTATION OF OPTIMAL CONTROLS
E. Polak [1968] 22 p refs Presented at Intern. System Dyn. Symp. in Australia, Aug. 1968
(Grant NsG-354)
(NASA-CR-96765) CFSTI: HC $3.00/MF $0.65 CSCL 09C

This paper seeks to show that the seeming ease with which nonlinear programming algorithms can be applied to discrete optimal control problems is deceptive, and that severe ill conditioning may occur due to the exponential nature of solutions of a difference equation. But is is also shown that it is possible to make effective use of nonlinear programming results, such as the convergence theory, in the construction of efficient, large-step, optimal control algorithms. The computational behavior of the algorithm method is compared with a parametric and a gradient method. K.W.

N68-34568*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A TIME OPTIMAL CONTROL STUDY OF A SECOND-ORDER LINEAR SYSTEM WITH DELAY
William R. Wells and Yasutada Kashiwagi (Va. Polytech. Inst.) [1968] 13 p refs Presented at the IEEE Session of the Joint Automatic Control Conf., Ann Arbor, Mich., 26–28 Jun. 1968
(NASA-TM-X-61207) CFSTI: HC $3.00/MF $0.65 CSCL 09C

An analytical solution for the time optimal control function and optimal trajectories of a second order linear system with a constant time delay is obtained. The system is a simple spring mass system with a constant time delay in the position variable. In addition to expressions for the control function and trajectories, an equation for the limit cycle has been established as well as a numerical construction of a pseudo switching curve for this system. The optimal control function was deduced from the maximum principle of Pontryagin for systems with delay. The two point boundary value problem associated with the differential-difference equation in the synthesis of the control was solved by use of a Newton–Raphson iteration scheme. The results are expressed in a form which can be easily compared to the well known results of the corresponding system without delay. Author

N68-34594*# Massachusetts Univ., Amherst.
A DESCRIBING FUNCTION ANALYSIS IN CLOSED LOOP SYSTEMS WITH PULSE FREQUENCY MODULATORS
R. V. Monopoli and J. F. Fitzgerald (Bell Telephone Labs., Inc., Whippany, N. J.) [1968] 15 p refs Presented at the Southwest IEEE Conf., Houston, Tex., 17–19 Apr. 1968
(Grant NGR-22-010-018)
(NASA-CR-96783) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Equivalent circuits are presented for integral and sigma pulse frequency modulators (IPFM and ΣPFM). Both contain linear elements and a nonlinearity with step discontinuities and hysteresis. A describing function is developed for this nonlinearity, and applied in the usual manner to the stability analysis of a unity feedback closed loop system with the modulator in the forward path. The transfer function for the linear part of the system is assumed to have a single pole at the origin. Analog computer results indicate that this analysis gives better predicted values for limit cycle periods than the quasi-describing function analysis previously reported. Author

N68-34601# California Univ., Los Angeles. Numerical Analysis Research.
ON PROBLEMS WITH BOUNDED STATE VARIABLES
Ira Bart Russak 1967 180 p refs
(Contract DA-31-124-ARO(D)-355)
(Rept.-67-8; AD-672528)

A problem in optimal control is considered. Problems of this type have been treated by Hestenes, Bolza, Gamkrelidze, Berkovitz, Guinn and others. However, except in the case of Guinn, the problems treated are special cases of the one here considered. In addition the results were obtained under more restrictive hypotheses. TAB

N68-34629# California Univ., Berkeley. Lawrence Radiation Lab.
CIRAN B LINEAR CIRCUIT-ANALYSIS PROGRAM—USER'S MANUAL
G. S. Tool and Joseph E. Katz 15 Apr. 1968 21 p refs
(Contract W-7405-eng-48)
(UCRL-18185) CFSTI: HC $3.00/MF $0.65

CIRAN B is a computer program used to perform ac steady-state analysis and transient analysis of linear networks. The circuit schematic and analysis options are described to the program by means of the CIRAN B problem-description language. The problem-description language is a format-free means of describing a circuit-analysis problem in terms familiar to circuit designers. A report designed to serve as a user's manual for the CIRAN B program is presented. An example of a typical circuit-analysis problem is presented to illustrate the many conveniences built in to enable the user to rapidly describe his circuit analysis problem to the computer program. A means of obtaining graphical output which can superimpose related curves for variational analysis on the same frame is described and illustrated by the sample problem. Author (NSA)

N68-34636# Bettis Atomic Power Lab., Pittsburgh, Pa.
FEEDBACK SYSTEM CONCEPTS
W. C. Bean Feb. 1968 225 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-724) CFSTI: HC $3.00/MF $0.65

Thirteen lectures dealing with feedback system concepts are presented. These lectures comprise the first half of a course in nuclear reactor plant dynamics and control in the Bettis Reactor Engineering School of the Bettis Atomic Power Laboratory, Pittsburgh, Pennsylvania. The basic principle of feedback is introduced, and then the conversion of physical systems to mathematical descriptions illustrated. Transfer functions, block diagrams and signal flow graphs are developed and used with numerous simple examples. The concept of stability is introduced, and several lectures are devoted to stability criteria and analysis, both from the characteristic equation approach of the Routh array and the open loop frequency response methods of Nyquist and Bode. Time domain behavior is studied and correlated with complex plane root locations. Both transient response and sinusoidal steady state response are characterized, and compensation-stabilization principles outlined. The first eleven lectures deal solely with linear systems. The last two lectures present an approach for analyzing some types of nonlinear systems: the small departure or perturbation method, and the large departure or describing function method. Author (NSA)

N68-34685# Joint Publications Research Service, Washington, D. C.
FINITE CONTROL OF LINEAR SYSTEMS WITH LUMPED PARAMETERS
A. G. Butkovskiy *In its* Computers—Boolean Functions and Linear Systems with Lumped Parameters 16 Aug. 1968 p 7-13 refs
(See N68-34683 21-08)

The control effects from a certain class of allowable effects are used to convert a system from a certain initial state to another given state in a given time. The procedure proposed offers the possibility of solving the boundary problems which arise in controlling the system by finding the equalizing functions from the initial condition so that the desired control is not only finite but also optimal. G.G.

N68-34692 European Organization for Nuclear Research, Geneva (Switzerland).
EQUIVALENT CIRCUIT ANALYSIS OF PHASE-LOCK BEAM CONTROL SYSTEMS
W. Schnell 17 Jul. 1968 60 p refs
(CERN-68-27)

The analytic method used reduces the actual multiple loop servo system to an equivalent circuit diagram containing an LC resonance circuit representing the beam, a system of damping impedance, and a number of driving sources. This circuit yields the self-resonance frequencies and damping factors of the system as well as its response to typical drive situations. The linear approximation to the phase equation is used and all electronic circuitry, including the phase detector of a closed-loop system, is assumed to be linear. The bunches of particles are treated as rigid bodies, characterized by their center of gravity only. Complete equivalent diagrams are derived for an equivalent circuit for the beam, the open-loop system, and the closed-loop phase lock system. Several examples are included. M.G.J.

N68-34728*# Arizona Univ., Tucson. Dept. of Electrical Engineering.
ANALYSIS AND SYNTHESIS OF DISTRIBUTED-LUMPED-ACTIVE NETWORKS BY DIGITAL COMPUTER Annual Report, 1 Sep. 1967–31 Aug. 1968
L. P. Huelsman 31 Aug. 1968 10 p refs
(Grant NGL-03-002-136)
(NASA-CR-96632) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The development of a general analysis program (distributed lumped activity network analysis) for determining the sinusoidal steady-state response of a distributed lumped activity network is discussed. General representation of the distributed element is achieved by dividing the distributing network into a number of sections of equal length. Resistance and capacitance associated with each section are determined and the line is approximated by a ladder network consisting of series lumped resistors and shunt lumped capacitors whose sum is equal in value respectively to the total resistance and the total capacitance associated with the distributed line. The transmission matrix for the entire network can be found by multiplying the transmission matrices of the individual sections, and the transmission matrices parameters of the network can then be obtained. A general problem structure for the synthesis of distributed lumped activity networks by optimization techniques contains subprograms which implement random grid search, ransom direction and step size search, pattern search, steepest descent, Newton–Raphson, and Fletcher–Powell. G.G.

N68-34777*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ANALYSIS AND DESIGN OF MODEL FOLLOWING CONTROL SYSTEMS BY STATE SPACE TECHNIQUES
Heinz Erzberger 18 Oct. 1967 10 p refs Presented at the Joint Autom. Control Conf., Ann Arbor, 26–28 Jun. 1968
(NASA-TM-X-61189) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A testing procedure is given which determines when the output of a linear plant can be made to follow a model by placing feedback around the plant. It is assumed that model and plant are described by a known set of state equations. The tests are developed for two configurations: the first of these, known as implicit model following or matching dynamics, the model does not actually become a part of the total system but enters only into the selection of the feedback law; in the second or real model following configuration, simulation of the model is required. In the absence of disturbances the conditions for perfect following are essentially the same for both configurations. For the case of implicit model following, the control law which achieves perfect following is also calculated. The results suggest a rational guide for deciding what type of model following is most appropriate for a given problem. Two examples, one of which is based on the lateral equation of motion of an aircraft, are given to illustrate the theory. Author

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N68-33735* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SPACE MAGNETIC ENVIRONMENT SIMULATION FOR SPACECRAFT TESTING
E. J. Iufer and P. W. Droll [1967] 9 p refs Presented at the ASTM/IES/AIAA 2d Space Simulation Conf., Sep. 1967 Submitted for publication
(NASA-TM-X-60461) CSCL 14B

Design, fabrication, and use of a low-cost facility for simulating the magnetic field environment found on earth and in deep space are described. This 12-foot coil facility is capable of mapping accurately the dc and ac magnetic fields produced by spacecraft assemblies, parts, and materials during space magnetic environment simulation by mapping in a test volume where the earth's magnetic field is attenuated by approximately 60 db and where the ambient noise level does not exceed 0.2 gamma in the spectrum from 0.1 to 50 Hz. Electrical standards and coils, incorporated in the facility, are used to calibrate magnetic instruments to accuracies of 0.2 gamma ± 0.002% of reading in the 1 to 100,000 gamma range. Author

N68-33772*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
JOHN F. KENNEDY SPACE CENTER: A SELECTIVE BIBLIOGRAPHY, FEBRUARY 1949–FEBRUARY 1968
Jul. 1968 34 p refs Revised
(NASA-TM-X-61174; GP-394) CFSTI: HC $3.00/MF $0.65 CSCL 22D

This is a bibliography of articles that have appeared in newspapers, periodicals, house organs, or Congressional hearings. Book titles are not included. The articles trace the evolution of the Kennedy Space Center from the Army Ballistic Missile Agency and Marshall Space Flight Center, Huntsville, Alabama. Articles showing the development of the Air Force Eastern Test Range are included. Entries are arranged chronologically, with spacecraft launches mentioned only incidentally. K.W.

N68-33854 Catholic Univ. of America, Washington, D. C.
LIGHT-GAS GUN ANALYSIS: EFFECTS OF DRIVER GAS EQUATION OF STATE
William Harold Gaetches (Ph.D. Thesis) 1967 124 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-15466

The effects of the driver gas equation of state on the analysis of two-stage hypervelocity launchers is investigated. Assuming one-dimensional isentropic flow of the driver gas, a method-of-characteristics solution in obtained for the interior ballistics which is adaptable to any equation of state for which the compressibility factor can be expressed as a function of gas temperature and density. Thermodynamic properties of the gas are developed from the statistical partition function. The translation, vibration and rotation contributions to the properties are considered identical for all equations of state. The only variation in properties stems from the potential contribution which is evaluated in terms of the compressibility factor. The peak pressure in the compression tube using the ideal gas equation of state is several times higher than that generated by the other equations, with the Rowlinson equation yielding the next highest peak pressure. Dissert. Abstr.

N68-33942# National Aeronautical Lab., Bangalore (India).
[NATIONAL AERONAUTICAL LABORATORY] Annual Report, 1966–1967
1967 99 p refs
CFSTI: $3.00/MF $0.65

Research activities are reported in the fields of aerodynamics, structural and materials sciences, propulsion, data handling and computer technology, instrumentation and control, and the mathematical sciences. In all, 88 programs were carried on by the National Aeronautical Laboratory in Bangalore, India. Various wind tunnels were erected; equipment, instrumentation, and data systems were developed and designed; and 12 projects were undertaken for organizations outside the laboratory. Laboratory personnel and publications are listed. M.W.R.

N68-34060# National Physical Lab., Teddington (England). Aerodynamics Div.
AN AERODYNAMIC INVESTIGATION FOR THE FIVE 50-STOREY TOWER BLOCKS PROPOSED FOR THE PING SHEK ESTATE, HONG-KONG
R. E. Whitbread and L. R. Wootton Sep. 1967 80 p refs
(NPL-AERO-SR-002) CFSTI: HC $3.00/MF $0.65

A 3-part wind-tunnel program has been undertaken to assist the designers of the project. The aspects covered include structural stability during construction, wind-induced oscillations of the completed towers and wind pressures on windows. Author (ESRO)

N68-34200# National Physical Lab., Teddington (England). Aerodynamics Div.
INFLUENCE OF SMALL HORIZONTAL INCLINATIONS OF THE WIND ON THE FORCES ON A MODEL OF A POWER-STATION BOILER HOUSE IN VARIOUS STAGES OF ERECTION
C. F. Cowdrey Oct. 1967 13 p refs
(NPL-AERO-SP-003) CFSTI: HC $3.00/MF $0.65

Results are given of measurements of the forces on a model of a power-station boiler house, in various stages of erection, for horizontal inclinations of the incident wind of up to 10° from the normal to the end face. Author (ESRO)

N68-34233# National Physical Lab., Teddington (England). Aerodynamics Div.
BRIEF DETAILS OF THE EXPERIMENT FACILITIES OF THE AERODYNAMICS DIVISION
R. C. Pankhurst and L. Pennelegion Jan. 1968 19 p refs Supersedes NPL-AERO-1205; See N67-34408
(NPL-AERO-1256; NPL-AERO-1205) CFSTI: HC $3.00/MF $0.65

Details are presented in tabular form of the 30 Experiment Facilities in NPL Aerodynamics Division used for incompressible and compressible flow research. The facilities include low speed, transonic, supersonic and hypersonic wind tunnels. Author (ESRO)

N68-34277# Los Alamos Scientific Lab., N. Mex.
DESIGN AND INITIAL PERFORMANCE OF A 20-MEV HIGH CURRENT SIDE COUPLED CAVITY ELECTRON ACCELERATOR
E. A. Knapp and W. J. Shlaer 1967 34 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y.
(LA-DC-9432; CONF-680515-12) CFSTI: HC $3.00/MF $0.65

The 800-MeV LAMPF linac will employ side-coupled standing wave accelerator tanks, therefore, to investigate the properties of side-coupled accelerator tanks the 20-MeV Electron Prototype Accelerator (EPA) was built and tested. The design, principle of operation, and performance of the EPA are presented. NSA

N68-34389# Los Alamos Scientific Lab., N. Mex.
BEAM TRANSPORT DESIGN FOR THE LAMPF INJECTOR
Paul W. Allison and Ralph R. Stevens [1967] 11 p Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y.
(LA-DC-9420; CONF-680515-4) CFSTI: HC $3.00/MF $0.65

The beam transport system from the ion source to the LAMPF linac is described. Design criteria are presented, and lens

aberrations of spherical lenses, quadrupole lenses, and bending magnets are discussed. Stability and space charge effects are also considered. NSA

N68-34448# Los Alamos Scientific Lab., N. Mex.
LINEAR ACCELERATOR FOR UNSTABLE PARTICLES
D. E. Nagle [1967] 7 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y., 1967
(LA-DC-9419; CONF-680515-14) CFSTI: HC$3.00/MF$0.65

The design of a linear accelerator for accelerating unstable particles such as pions is considered. This concept is considered due to high-intensity beams which will become available from meson factories, new accelerating structures, and new techniques such as superconducting cavities. Design parameters for a linac for accelerating pions from 400 to 1200 MeV are presented. NSA

N68-34459# Ballistic Research Labs., Aberdeen Proving Ground, Md.
THE WIND TUNNEL FREE FLIGHT TESTING TECHNIQUE
Anders S. Platou Jun. 1968 31 p refs
(BRL-1402; AD-672510)

The free flight wind tunnel technique has been used successfully to obtain aerodynamic coefficients on a variety of configurations with and without spin. High mass to moment of inertia ratio models are electroformed as 0.001 in. thick nickel shells with tungsten cores at the center of gravity (CG). This permits wide CG variations and provides models which can withstand the high speed, high temperature flows. The model launcher is based on the principle of an inverted pea shooter. A 1/4 in. diameter tube in inserted into the aft portion of the model through the model base, and compressed air acting through the tube on the tungsten core propels the model forward. Spin can be imparted to the model with an air turbine just prior to launch. Cones have been launched with success up to 10,000 rpm, while high fineness ratio models have been launched at 40,000 rpm with moderate success. Author (TAB)

N68-34730# Factory Mutual Research Corp., Norwood, Mass.
GLOVEBOX FIRE SAFETY: A GUIDE FOR SAFE PRACTICES IN DESIGN, PROTECTION AND OPERATION
1967 133 p refs Prepared for AEC
(TID-24236) GPO: HC$1.00; CFSTI: MF$0.65

Information is included on glovebox fire and explosion behavior, safety program administration, principles of glovebox construction, ventilation, fire detection systems, fire control within gloveboxes, and fire protection of rooms and buildings. Information is also included on glovebox fires and explosions, high expansion foam generators, protection of closed containers against internal explosion, and criteria for fire tests. NSA

N68-34743# Ballistic Research Labs., Aberdeen Proving Ground, Md.
BALLISTIC RESEARCH LABORATORIES' WIND TUNNEL COMPRESSOR PLANT
Ernest P. Reklis May 1968 99 p refs
(BRL-TN-1694; AD-672059)

The wind tunnels branch of the Exterior Ballistics Laboratory (EBL), Ballistic Research Laboratories (BRL), Aberdeen Proving Ground, Maryland operates three supersonic wind tunnels and one hypersonic wind tunnel. The supersonic wind tunnels use flexible plate nozzles and may be operated up to a Mach Number of 5.5, whereas the hypersonic tunnel uses axisymmetric nozzles for operation at Mach Numbers 6, 7.5 and 9.2. Air is furnished to the tunnels by centrifugal compressors operating in a closed loop system. There are two compressor plants. Author (TAB)

N68-34745# California Univ., Berkeley. Lawrence Radiation Lab.
BEVATRON OPERATION AND DEVELOPMENT, 56, OCTOBER–DECEMBER 1967
Kenneth C. Crebbin and Robert Frias 1 Apr. 1968 10 p
(Contract W-7405-ENG-48)
(UCRL-18228) CFSTI: HC$3.00/MF$0.65

The beam was on for 90.6% of the scheduled operating time. The beam was off 4.6% of the scheduled operating time because of equipment failure and 4.8% of the scheduled operating time for experimental setup, tuning, and routine checks. During the quarter, the Bevatron accelerated 1.45×10^{18} protons. Fractures were detected in the dovetail area of the main motor generator poles. Monitoring and inspection procedures have been established. Author (NSA)

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N68-33617 Michigan Univ., Ann Arbor.
A STUDY OF COLUMN SEPARATION ACCOMPANYING TRANSIENT FLOW OF LIQUIDS IN PIPES
Robert Arwed Baltzer (Ph.D. Thesis) 1967 279 p
Available from Univ. Microfilms: HC $12.60/Microfilm $3.80 Order No. 67-15589

The theoretical analysis of liquid column separation in a horizontal pipe is divisible into two distinct phases. The first phase concerns the transient flow conditions in the pipe prior to the development of a vapor cavity, which is to say while the pipe is flowing full. The second phase treats the actual column separation—the formation, growth, and collapse of a vapor cavity. This latter phase is an example of unsteady, free-surface flow. In both phases of the analysis the liquid motion is considered to be one-dimensional, transient flow in which frictional resistance losses are included. Mathematical interpretation of the flow results in the development of two sets of nonlinear, hyperbolic, partial differential equations, depicting each of the phases of the flow. Each set of equations is transformed into the appropriate characteristics equations, which are subsequently rewritten as finite difference equations arranged for solution by high-speed, digital computer. In summary, a highly sophisticated digital model is created by which the column-separation phenomenon can be theoretically simulated. Dissert. Abstr.

N68-33622 Johns Hopkins Univ., Baltimore, Md.
ON WAKES IN STRATIFIED FLUIDS
Gerald Saul Janowitz (Ph.D. Thesis) 1967 109 p
Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-13807

Consideration is given to two-dimensional flow induced by a body moving with constant speed through a linearly stratified fluid. It is assumed that the flow at distances from the body is so large that the details of the body shape are unimportant, and the flow may be considered as induced by a point disturbance having finite drag but no lift. The Fourier transformation of the linearized governing equations is used for solving the transforms of the dependent variables; these transforms are inverted by the method of residues. The boundary conditions at the body are replaced by a singularity at the origin corresponding to the drag of the body. In integral form, the asymptotic solutions of Long are recovered and the magnitudes of the velocity perturbations are related to the drag. Dissert. Abstr.

N68-33636 Oregon State Univ., Corvallis.
GENERALIZED MEASURES OF DEFORMATION RATES IN NON-NEWTONIAN HYDRODYNAMICS AND THEIR APPLICATIONS TO SOME FLOW PROBLEMS
Kewal Singh Sra (Ph.D. Thesis) 1967 152 p
Available from Univ. Microfilms:: HC $7.20/Microfilm $3.00 Order No. 67-13906

Integral representations for the generalized measures of deformation and deformation-rates have been obtained and suitable constitutive equations using these measures have been developed for viscoelastic materials. These new constitutive equations are then applied to study some flow problems. In order to assess the comparative advantage of this approach over the existing nonlinear theories of continuous media, a brief review of the latter has been first made. In this review, special attention has been drawn to the ever-increasing complexity of the constitutive equations which involve a number of terms in powers and products of the ordinary measures of strain or strain rate and several unknown response functions of invariants of kinematic matrices. This complexity in these constitutive equations has arisen since generalized measures have not been used and consequently the order of the measures could not be fixed. Dissert. Abstr.

N68-33642*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LAMINARIZATION OF A TURBULENT BOUNDARY LAYER AS OBSERVED FROM HEAT-TRANSFER AND BOUNDARY LAYER MEASUREMENTS IN CONICAL NOZZLES
Donald R. Boldman, James F. Schmidt, and Anne K. Gallagher Washington Sep. 1968 34 p refs
(NASA-TN-D-4788) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Heat transfer measurements were obtained in 30° and 60° half-angle of convergence nozzles at a nominal stagnation temperature of 970°R (539 K) and over a range of stagnation pressures of 2.0 to 20.4 atmospheres (2.03×10^5 to 20.67×10^5 N/m^2). These conditions provided nozzle throat Reynolds numbers based on diameter of about 6.0×10^5 to 5.0×10^6. Boundary layer time-mean velocity and temperature measurements were obtained at one station in a water cooled pipe inlet and at a subsonic (Mach number ≤ 0.08) station in each nozzle at stagnation pressures of 3.1 and 20.4 atmospheres (3.14×10^5 and 20.67×10^5 N/m^2). The heat transfer and boundary layer surveys suggested the occurrence of laminarization of an initially turbulent boundary layer. Author

N68-33661 Delaware Univ., Newark.
CHARACTERISTICS OF THE GAS-LIQUID INTERFACE IN TWO-PHASE ANNULAR FLOW
Ronald Walter Swanson (Ph.D. Thesis) 1966 278 p
Available from Univ. Microfilms: HC $12.60/Microfilm $3.60 Order No. 67-11739

A method of measuring the instantaneous liquid film thickness on the walls of a pipe was developed and tested. The method involved recording the modulations in electrical resistance caused by variations in liquid depth between two thin parallel wires placed perpendicular to the direction of flow and extending from one wall of the pipe to the other. By partially insulating the wire, it was possible to measure the film thickness on one side of the pipe at a time. Film thicknesses were measured for annular flow of the air–water system in horizontal pipes at near-atmospheric pressure. Tests at six different combinations of air and water rates were made in a one-inch pipe, and at two combinations in a two-inch pipe. Dissert. Abstr.

N68-33701 Minnesota Univ., Minneapolis.
FLUID MECHANICS OF ENTRAINMENT THROUGH LIQUID-LIQUID AND LIQUID-SOLID JUNCTURES
Ronald Thomas Perry (Ph.D. Thesis) 1967 130 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-14639

The purpose of this research was to study the fluid entrainment process and the flow mechanisms involved, with the ultimate goal of predicting and preventing or postponing the occurrence of entrainment. Three experimental systems were investigated: a liquid jet plunging into a reservoir of the same liquid; a continuous solid passing into a liquid reservoir; and, a liquid film being coated onto a moving solid. A marked similarity in the behavior of each of these systems was noted. Air entrainment was characterized by the formation of a thin air film at the juncture as the dynamic contact angle attained a value of 180°. Bubbles were carried into the flow as a result of the violent oscillation and subsequent breakup of this air film. A proposed physical model of the process based on a balance of forces acting through the juncture indicated that the dynamic wetting force was the resultant of the static wetting force and viscous shear and normal stresses in the liquid. That velocity of the faster-moving surface—the solid or the liquid jet—which produced sufficient viscous forces to overcome the surface wetting forces was then termed the velocity of entrainment. Presuming that boundary layer theory could be used to describe the liquid flow in the dyanmic meniscus, a theoretical model was developed. This model was found to give good correlation with obtained data and qualitative observations. The theory predicted that application of an additional force to the junction to counteract the effect of the viscous forces would postpone the onset of entrainment. This was also observed experimentally by directing a fluid jet against the juncture. Calculated theoretical increases in entrainment velocity agreed with previously published experimental results where this force was applied by means of a pressure differential across the dynamic juncture. Dissert. Abstr.

N68-33703 Washington Univ., Seattle.
ON THE MECHANISM OF WIND-SLICK GENERATION
William Lee McLeish (Ph.D. Thesis) 1967 123 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-14191

In this study, wind slick patterns were examined in detail. They were generally much less regular than previously described, intersecting frequently and having variable widths. In laboratory experiments, dust settling from an air stream floated on the water and assumed patterns similar to those of wind slicks. Strained turbulence in the water was shown to be a sufficient factor for the formation of these patterns. Furthermore, internal tracers showed isolated longitudinal vortices near the surface as elements of the turbulent flow but did not show Langmuir circulation. Other experimenters have not found such series of vortices in fully developed turbulent flows near a solid boundary. Approximately parallel lines of dust, sand, snow, and plankton are found with turbulent shear flows, indicating that such parallel configuration in turbulent flows is not unusual. These observations suggest that wind slick generation can be attributed to the turbulent shear flow itself. Dissert. Abstr.

N68-33751 Case Inst. of Tech., Cleveland, Ohio.
TRANSPORT PHENOMENA OF GENERAL NON-EQUILIBRIUM GAS SYSTEMS
Eddie Lee Walker (Ph.D. Thesis) 1967 173 p
Available form Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-16110

The theory of gas mixtures is extended to cases where there may be large differences in the flow velocities and/or temperatures of the species in the mixture; the species are *not* assumed to be in local equilibrium. Transfer equations for the thirteen moments of each species are constructed relative to the species' flow velocity; the equations are closed by means of the *Grad approximate velocity-space solution* for the species' distribution functions. Various statistical collision models are next presented as

possible substitutes for the Boltzmann binary collision operator, with a view towards duplicating the partial collision integrals of that operator. Finally, transport quantities are calculated for: (a) weakly ionized gas; (b) binary Maxwell molecule gas; (c) fully ionized gas. Dissert. Abstr.

N68-33769 Rice Univ., Houston, Tex.
MOLECULAR STRUCTURE CORRECTIONS FOR APPLICATION OF THE THEORY OF CORRESPONDING STATES TO NONSPHERICAL PURE FLUIDS AND MIXTURES
James Woodrow Leach (Ph.D. Thesis) 1967 149 p
Available from Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 67-13096

A procedure for accounting for deviations from the principle of corresponding states of spherical fluids due to structural dissimilarities on non-spherical fluids is presented. This procedure defines temperature and density dependent molecular shape factors which are used to multiply the critical parameters of pure fluids and individual critical constants appearing in the pseudo-critical parameters of mixtures. A theoretical derivation of these factors and a discussion of their behavior and properties are given. Analytical correlations of the shape factors are presented; and examples are given of the prediction of density, enthalpy deviations, viscosity, fugacity coefficients, and K-values. Calculations of fugacities and K-values of non-spherical components and of solutions require an improvement in the pseudo-critical equations derived for spherical fluids. This is accomplished by introducing molecular shape factors into the pseudo-critical definitions. Dissert. Abstr.

N68-33770 Rice Univ., Houston, Tex.
THE HYDRODYNAMIC FORCES ACTING ON A CYLINDER IN AN OSCILLATING FLOW
Charles Michael Mc Bride (Ph.D. Thesis) 1967 44 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-13103

Hydrodynamic forces acting on a body in an oscillating flow are investigated. A body traveling through a fluid imparts momentum to the fluid, thereby establishing a wake. If the body then reverses its direction of motion, the force it will experience will be influenced by the existence of the wake. Viscous drag is considered in oscillating flows. A simple model for the wake near the body is substituted for H. Schlichting's model which applies for locations away from the body. These two models are assumed to define the wake velocity at any location from the body. For periodic motions it is shown that the maximum forces that the body experiences occur after the first reversal of its motion. For sinusoidal motion, the relative velocity between the body and the fluid in the second half-cycle is calculated as a function of time.

N68-33773 Houston Univ., Tex.
ADSORPTION OF GASES ON THE INTERNAL SURFACES OF POROUS MATERIALS
Beverly Ching-cheng Chen Yu (Ph.D. Thesis) 1967 105 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-16120

Present theories for adsorption of gases on solid surfaces, such as the Langmuir and the BET theories, treat all gas molecules disappearing from the free gas phase as adsorbed on the solid surface. In porous materials another gas phase may exist within the pores. This possibility has been ignored in the existing theories of adsorption. The new approach taken here considers the equilibrium between three phases: free gas, pore gas and adsorbed gas. The interaction energy between gas in the pore space and the solid matrix is described by the London dispersion force. The canonical partition functions for the three phases are computed. The equilibrium between these three phases yields the pressure of the free gas as a function of the total number of molecules in both the pore gas phase and the adsorbed gas phase. The Langmuir adsorption isotherm and the BET equation are modified by the addition of a term which is linear in pressure. Dissert. Abstr.

N68-33846 Saskatchewan Univ., Saskatoon.
THE BEHAVIOUR OF PRESSURE WAVES IN A BRANCHED DUCT
David Harold Male (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-16529

The behavior of a flat topped pressure wave in a junction formed by the intersection of two ducts of equal cross-sectional area has been examined. The development of the wave action in a 90-degree junction has been studied using the Toepler schlieren method and the hydraulic analogy to the unsteady flow of a gas. A comparison of the schlieren photographs with photographs of the analogy shows that the main features of the wave motion are present in the analogy although rarefaction waves and temperature discontinuities cannot be detected. Analogue studies of a 45 and 135-degree junction are also presented. Two dimensional quasi-steady flow models are proposed for the flow in the junction for subsonic and sonic entrance velocities. The pressure and velocity at the junction entrance and the amplitude of the transmitted waves in the two downstream branches of the junction have been calculated using these models. Dissert. Abstr.

N68-33868 California Univ., Berkeley.
ANALYSIS OF SPACE-CHARGE PRECIPITATION
Larry Eugene Faith (Ph.D. Thesis) 1967 238 p
Available from Univ. Microfilms: HC $10.80/Microfilm $3.10 Order No. 67-11618

In this study precipitation of charged particles by their own space-charge is investigated both theoretically and experimentally. Here mathematical models are developed for the precipitation of charged particles from a gas moving through a cylindrical precipitator. The first two models predict the precipitation of uniform-size particles under plug-flow and turbulent-flow conditions. The plug-flow model is one-dimensional and is solved exactly. The turbulent-flow model is two-dimensional and requires numerical techniques for solution. Two other models extend the above models to the precipitation of a particulate mixture having a distribution of particle diameter and charge. The plug-flow extension is solved numerically by the Runge-Kutta-Gill integration. The turbulent-flow extension is solved by an iterative technique. Dissert. Abstr.

N68-33870 Oregon State Univ., Corvallis.
DROP SIZE DISTRIBUTIONS PRODUCED BY TURBULENT PIPE FLOW OF IMMISCIBLE LIQUIDS
Stanley Browning Collins (Ph.D. Thesis) 1967 163 p
Available from Univ. Microfilms: HC $7.60/Microfilm $3.00 Order No. 67-11805

Drop size distributions produced by the turbulent pipe flow of dispersions of immiscible liquids were measured photographically. A mathematical model was developed which predicted both the shape of the experimentally observed distributions and the experimentally observed kinetics of the breakup process. The mutually saturated water and organic phases were pumped separately and mixed by injecting the organic phase along the axis of the vertical, 0.745-inch ID, 40-foot pipe which formed the test section. Provision was made to allow the dispersion formed by the action of the turbulence to be photographed at 27, 209, 421, and 576 pipe diameters below the mixing jet. The position of the focal plane of the camera along the radius of the pipe could also be adjusted. Photographs were thus obtained at dimensionless distance of 0.05, 0.1 and 0.4 from the wall. Dissert. Abstr.

N68-33885 Michigan Univ., Ann Arbor.
TWO-DIMENSIONAL JET ATTACHMENT
Charles Clayton Perry (Ph.D. Thesis) 1967 117 p
Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-15672

This study of two-dimensional jet attachment (the Coanda effect) concerns the physical nature of attached-jet flow, and the appropriateness of some of the assumptions incorporated in the Bourque and Newman analytical model; the effect of the location and orientation of symmetrically disposed sidewalls on the attachment distance; and the effects of nozzle aspect ratio and Reynolds number. It is shown here that with a very simple change in the Bourque and Newman control-volume model it is possible to predict attachment distance with reasonable accuracy without resorting to unrealistic values of the jet-spread parameter. This is accomplished by introducing a base-pressure correction coefficient, $C'_p = (P_\infty - P_B) / (P_\infty - P_B')$, where P_∞ is the pressure on the convex side of the jet, P_B is the separation bubble pressure, and P_B' is the corrected base pressure. Selection of $C_p' = 2$ and σ (the jet-spread parameter) equal to 10 yields satisfactory agreement between theory and experiment. The experimental results demonstrate that the attachment distance is unaffected by the presence or location of a second sidewall if it is at least as far from the jet as the wall upon which attachment takes place. Dissert. Abstr.

N68-33948*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
HYPERSONIC TURBULENT BOUNDARY LAYER MEASUREMENTS USING AN ELECTRON BEAM Final Report, Oct. 1966–May 1968
J. E. Wallace Aug. 1968 59 p refs
(Contract NSR-33-009-029)
(NASA-CR-96612; CAL-AN-2112-Y-1) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Direct measurements of density and density fluctuations were obtained in the cold-wall turbulent boundary layer on a shock tunnel nozzle wall using an electron beam probe. Static temperatures and total enthalpy in the boundary layer inferred from the density measurements and accompanying pitot pressure measurements are found to be significantly below the values predicted by the Crocco energy relation. Measurements of skin friction and heat transfer on the nozzle wall are found to be in agreement with previous data obtained at higher Reynolds numbers. Author

N68-33976 Oregon State Univ., Corvallis.
VERTICAL JET DIFFUSION IN NON-LINEAR DENSITY STRATIFIED FLUID
Donald John Baumgartner (Ph.D. Thesis) 1967 178 p
Available from Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-13891

The simplified equations of motion proposed by Morton to determine the extent of vertical travel of a forced plume in a linear density stratified environment were re-written and solved in a way which allowed them to be applied to any nonlinear profile of density. For application to any specific situation it was shown that the solution did not have to commence from a virtual point source, but rather could start from the actual source of finite diameter, progressing in steps through a number of segments of variable length. In each segment a linear density gradient was specified which closely approximated the actual gradient. A method was developed to find the virtual point source, however, for those cases requiring the comparison of flows in a linear gradient. The equations of motion provided a method for achieving similarity between model and prototype and this method was employed in designing the physical model studied incorporated in this study. Dissert. Abstr.

N68-33990 Delaware Univ., Newark.
PIPE ENTRANCE FLOW OF ELASTIC LIQUIDS
Ernest Alan Uebler (Ph.D. Thesis) 1966 168 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-11742

Local velocities were measured as functions of position coordinates for an elastic liquid in a two dimensional flow field, namely flow from a large reservoir into a round pipe. Measurements were made at three different flow rates, and they extended from the upstream reservoir, through the entry region, to and including the fully developed pipe flow region. Photographs of tracer particles in the fluid provided the coordinate-velocity information. The elastic liquid tested was a water solution of a polymeric additive. The velocity profiles for this material were found to be partially developed prior to entry into the tube, and they became quite flat just at the entrance plane and then gradually developed proceeding down the tube to the fully developed profile. Extremely large velocity gradients were observed at the entrance plane near the tube wall. Dissert. Abstr.

N68-33993 Houston Univ., Tex.
A BOUNDARY METHOD FOR CALCULATING THE GROWTH OF AN INSTABILITY IN A SYSTEM OF TWO FLUIDS
Nadim Eissa Nasir (Ph.D. Thesis) 1967 44 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-16144

A boundary method is presented to solve numerically the problem of gravitational instability for large perturbations in a system of two viscoelastic materials. It is assumed that the inertial terms in the Navier–Stokes equations could be neglected because of the large viscosities. The resulting linear equations were solved by finite sine and cosine transforms. The infinite series solutions were truncated, an initial interface was assumed, the constants of integrations were found from the boundary conditions, and, hence, the velocity fields were determined. The interface was then advanced to a new position. Thus, the new shape of the interface was traced for any time. When the initial perturbation was small the results were nearly those obtainable by the linear theory. Numerical results are presented for large and small perturbations. Dissert. Abstr.

N68-34010# National Physical Lab., Teddington (England). Aerodynamics Div.
A RIGOROUS DERIVATION OF THE KARMAN-SCHOENHERR SKIN FRICTION FORMULA
P. Bradshaw Dec. 1967 6 p refs
(NPL-AERO-1252) CFSTI: HC $3.00/MF $0.65

A 'Karman-Schoenherr' type of skin friction law is rigorously derived from the inner-layer (logarithmic) and outer layer (defect) velocity profiles without any other assumptions. Numerical values, obtained by using modern profile data, are very near the original Schoenherr line. Author (ESRO)

N68-34017*# Brown Univ., Providence, R. I. Div. of Engineering.
THE EFFECT OF FINITE BOUNDARIES ON THE MOTION OF PARTICLES IN NON-NEWTONIAN FLUIDS—1
Bruce Caswell Jun. 1968 53 p refs
(Grant NGR-40-002-053)
(NASA-CR-96547) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A perturbation analysis is presented, based on the constitutive relation of incompressible Rivlin–Ericksen fluids. It is pointed out that the Rivlin–Ericksen theory appears to adequately describe the stresses in real fluids undergoing slow flows, but it differs from experiment when the same fluids undergo certain other motions. Therefore it is considered desirable to classify the flow which the real fluid is undergoing rather than to classify the fluid according to the constitutive relations. Consideration is given to Nth order viscoelastic flows. The justification for the assumption of the Nth order flow depends upon the relative magnitudes of characteristic

times for the flow and the fluid. This is closely analogous to the assumption of isochoric flow of a compressible fluid which is justified when the characteristic velocity of the flow is small compared to that of the fluid. Data are also presented to show that stress tensor theories involving memory functionals, usually integrals, reduce to slow flow approximations by expansion of the strain tensor as a Taylor's series in powers of the time lapse. M.G.J.

N68-34028 Pennsylvania Univ., Philadelphia.
EFFECT OF INERTIA TERMS ON A FULLY DEVELOPED AXISYMMETRIC LAMINAR FLOW
Elemer Makay (Ph.D. Thesis) 1967 391 p
Available from Univ. Microfilms: HC $17.80/Microfilm $5.00 Order No. 67-12776

The basic subject discussed in this work consists of a solution to a general form of the Navier–Stokes equation. The physical idealization associated with this problem is of parallel rotating walls, with a small constant gap in between. The class of problems being studied is limited to the fully developed laminar flow and both compressible and incompressible cases are discussed. These types of flows find wide application in the practical field of design for rotating machinery. The governing differential equations with the proper set of boundary conditions were separately converted into an integral equation of a type usually called a Fredholm equation of the second kind. The procedure used for the solution of these integral equations is based on the extension of Fredholm's theory using successive substitution. Dissert. Abstr.

N68-34089*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECTS OF BOUNDARY LAYER BUILDUP IN SHOCK TUBES UPON CHEMICAL RATE MEASUREMENTS
Marvin Warshay Washington Sep. 1968 18 p refs
(NASA-TN-D-4795) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A theory by Mirels was employed to investigate the effects of boundary layer buildup in shock tubes upon dissociation rate measurements. A comparison was made of bromine dissociation rate constant which were obtained assuming no boundary layer buildup to those obtained when boundary layer was taken into account. Mirels' wholly turbulent boundary layer case was used in the latter calculations. At low temperatures (1264°K), where reaction rates are low, the measured rate constant increased significantly; at high temperatures (1827°K), where rates are high, the effect was negligible. In quantitative terms, the activation energy decreased from 31.5 to 30.0 kilocalories (1.32×10^5 to 1.26×10^5 j). Author

N68-34101# Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
OF SHOES AND SHIPS AND SEALING WAX
J. R. D. Francis 14 Mar. 1967 15 p
CFSTI: HC $3.00/MF $0.65

The relation of hydraulics in Civil Engineering to fluid mechanics is shown. Examples of practical problems civil engineers have to deal with are given: sediment transport, waves in their relationship to wind, water piping and sewage schemes. ESRO

N68-34102#
FREE JET BOUNDARY LAYER FOR AN EQUILIBRIUM DISSOCIATING GAS
L. I. Vereshchagina-Myshkova [1968] 5 p refs Transl. into ENGLISH from Gazodinamika i Teploobmen. (Leningrad), no. 1, 1968 p 81–86
CFSTI: HC $3.00/MF $0.65

Flow in the mixing zone taking account of gas dissociation which occurs in the free jet boundary layer during hypersonic flow around a body is discussed. It is assumed that: (1) the classical Prandtl boundary layer conception is valid, according to which the dissipative layer in the separation zone does not influence the external inviscid gas flow field; and (2) the dissociation is equilibrium (the degree of dissociation at each point of the layer corresponds to the temperature at that point). Author

N68-34110#
ON A COMPUTATION OF THE SUPERSONIC FLOW AROUND BLUNT BODIES BY UTILIZING THE COMPLETE NAVIER–STOKES EQUATIONS
B. M. Pavlov [1968] 8 p refs Transl. into ENGLISH from Izv. AN SSSR, Mekh. Zhidk. i Gaza (USSR), no. 3, 1968 p 128–133
CFSTI: HC $3.00/MF $0.65

A numerical method of solving problems of the stationary supersonic low density gas flow around blunt bodies is expounded. Compressibility, viscosity, and heat conduction effects of the gas washing over the blunt body are essential in the considered flow mode. The flow field is investigated by using the two-dimensional Navier–Stokes equations for a compressible gas, which are integrated to the finite domain around the streamlined body. The solution of the boundary value problem is sought by the method of building-up. An explicit difference scheme is applied to approximate the nonstationary Navier–Stokes system. The main purpose is to test the method of computation. The nature of the build-up to the stationary solution and the peculiarities of a computation by the chosen difference scheme are clarified; the influence of boundary conditions assigned on certain surfaces within the flow on the numerical solution is analyzed; and the accuracy of the computation is estimated. Author

N68-34144 Michigan Univ., Ann Arbor.
UNSTEADY FLOWS IN DISTRIBUTED OUTFLOW SYSTEMS
David Carl Wiggert (Ph.D. Thesis) 1967 122 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-15723

Unsteady, nonuniform flows in pipelines which experience leakage are analyzed. Particular attention is given to the orifice manifold, since it provides a well-defined outflow relation, and can be applied to practical problems. Unsteady flows in a continuous manifold can be treated in several ways: (1) when the leakage parameter is of such magnitude that capacitance effects can be neglected, the continuity and momentum relations reduce to a nonlinear parabolic equation; (2) more generally, if the elastic properties are included, the governing equations become hyperbolic, and a pressure-pulse wave speed is introduced; (3) impedance methods provide analytical solutions of the linearized equations for steady periodic flows, and encompass the two above-mentioned situations. Numerical computer solutions of the nonlinear equations are based on the following techniques: (1) the Runge–Kutta method for steady flows, (2) the method of characteristics for the hyperbolic equations, and (3) for the parabolic relation, a finite-difference approximation based on relaxation methods. Dissert. Abstr.

N68-34297*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DIFFUSIVE SEPARATION IN FREE JETS OF NITROGEN AND HELIUM MIXTURES
D. I. Sebacher, R. W. Guy, and L. P. Lee [1968] 13 p refs Presented at the 6th Intern. Symp. on Rarefied Gas Dynamics, Cambridge, Mass., 22–26 Jul. 1968
(NASA-TM-X-61220) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Measurements of relative species concentration, jet structure, and N_2 rotational temperature using an electron beam are presented for free jets of nitrogen-helium mixtures. The results are compared with the predictions of the method of characteristics for the temperature distribution and with Sherman's nearly continuum theory for diffusive separation. Author

N68-34302#
ESCAPE OF A SUPERSONIC JET INTO A VACUUM
G. I. Averenkova and E. A. Ashratov [1967] 14 p refs Transl. into ENGLISH from Vychisl. Metody i Programmir. (Moscow), no. 7, 1967 p 225–241
CFSTI: HC $3.00/MF $0.65

Jet escape from a nozzle with uniform exit flow is considered, and the most essential flow singularities analyzed. Some peculiarities of the flow far away from the nozzle exit are considered, and flow peculiarity for axisymmetric expansion into a vacuum is noted. Influence of velocity field nonuniformity on the nozzle exit is described in terms of the computation of the flow of a supersonic jet into a vacuum from a nozzle with arbitrary parameter distribution at the exit. Attention is given to the geometric flow picture as well as to the influence of a specific initial profile of the flow and its extention from the initial characteristic. An approximate computatior method is given for the flow field for the escape into a vacuum.
M.W.R.

N68-34328*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
UNSTEADY LIFT FORCES GENERATED BY VORTEX SHEDDING ABOUT A LARGE, STATIONARY, AND OSCILLATING CYLINDER AT HIGH REYNOLDS NUMBERS
George W. Jones, Jr. May 1968 31 p refs Presented at the ASME Symp. on Unsteady Flow, Philadelphia, 6–9 May 1968
(NASA-TM-X-61214) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A wind-tunnel study was made of the unsteady lift (crosswind) forces on a large, two-dimensional cylinder with axis perpendicular to the flow. The forces were measured at Reynolds numbers from 0.36 million to 18.7 million at Mach numbers up to 0.6 with the cylinder held both stationary and oscillated laterally. The mean-drag and the Strouhal number of the unsteady lift forces on the stationary cylinder followed the trends established by previous investigators. At higher, hitherto unexplored Reynolds numbers, the mean-drag was approximately 0.54, and the Strouhal number was approximately 0.3. The unsteady root-mean-square lift force on the stationary cylinder was defined over the flow parameter range investigated. For the oscillated cylinder, an unsteady lift force due to motion was found to exist at cylinder frequencies near the vortex-shedding frequency of the stationary cylinder. This unsteady lift due to motion was found to be a destabilizing aerodynamic damping force at frequencies below the stationary cylinder vortex-shedding frequency which shifted abruptly to a stabilizing damping force at frequencies above the vortex-shedding frequency.
Author

N68-34332 Adviesbureau der Genie, The Hague (Netherlands).
SHOCK TUNNEL ANALOGIES WITH REFLECTING WALLS [SCHOKTUNNELANALOGIEEN BIJ BREEKWANDEN]
R. W. Trense Apr. 1968 17 p In DUTCH
(Rept.-189; TDCK-50849)

A mathematical analysis is presented of the effect of reflecting walls on the explosive shock wave propagation in a gas-filled room. The reflecting wall is treated as an analog of a breaking membrane in a shock tunnel. Several numerical examples are included.
Transl. by K.W.

N68-34363# National Physical Lab., Teddington (England). Aerodynamics Div.
CONVECTION VELOCITIES IN A VISCOUS SUBLAYER
J. A. B. Wills 23 Nov. 1967 23 p refs
(NPL-AERO-1251, ARC-29667) CFSTI: HC $3.00/MF $0.65

Measurements of convection velocity of the u-component fluctuations have been made within the viscous sublayer of a fully-developed turbulent channel flow, in an attempt to distinguish between 'active' and 'passive' theories of the sublayer. The results show that the turbulence is convected much faster than the local mean velocity, typically at 0.7 U_1, which seems to support the passive sublayer concept. Comparison with other work indicates a need for further measurements to remove some existing discrepancies.
Author (ESRO)

N68-34379# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TOTAL MIRROR REFLECTION OF MOLECULES AT SMALL ANGLES OF INCIDENCE AND ITS INFLUENCE ON MOLECULAR FLOW OF GAS IN VERY NARROW CAPILLARIES [POLNOE ZERKALNOE OTRAZHENIE MOLEKUL PRI MALYKH UGLAKH PADENIYA I EGO VLIYANIE NA MOLEKULYARNOE TECHENIE GAZA V OCHEN UZKIKH]
B. V. Deryagin and N. N. Fedyakin 4 Oct. 1967 21 p refs Transl. into ENGLISH from Akad. Nauk SSSR, Inst. Fiz. Khimii, Sb. Dokl. Na Vtoroy Konf. (USSR), 1964 p 244–257
(FTD-HT-23-786-67; AD-672332)

The kinetics of water evaporation from glass capillaries with radii from 0.02 to 3 microns was studied. The data obtained for radii from 0.5 to 1.5 microns are in agreement with calculations by Knudsens formula.
Author (TAB)

N68-34428# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
POTENTIAL FLOW OF A FILM DOWN AN INCLINED PLATE
Robert C. Ackerberg Jun. 1968 23 p refs
(Contract DA-31-124-ARO(D)-444)
(PIBAL-68-14; AROD-6152-8-E; AD-672092)

The flow of a liquid film along a semi-infinite flat plate due to gravity is considered, the fluid being assumed inviscid and incompressible. When the Froude number Fr, based on the initial film thickness and velocity, is large compared to unity, asymptotic solutions can be found by the method of matched expansions. The fluid speed and deflection, and the pressure gradient are found uniformly to O(Fr to the -2nd power). Hydraulic theory enters as the first term in the outer expansion, which is valid far downstream from the leading edge. When the liquid falls vertically and the plate is removed, the motion represents half of a freely falling jet.
Author (TAB)

N68-34465# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
COMPUTATION OF AXIAL-SYMMETRIC TRANSONIC SWIRL FLOWS BY THE UNSTEADY FLOW APPROACH. APPENDIX: CHECK OF THE ACCURACY OF THE RESULTS
J. V. Armitage, Karl G. Guderley, and Emma M. Valentine Apr. 1968 82 p
(ARL-68-0070; AD-672282)

Steady flows through a Laval nozzle with and without swirl are computed as the long time limit of unsteady flow fields by means of a three dimensional method of characteristics. In an appendix the accuracy of the results is checked by means of integral relations that hold for steady flows.
Author (TAB)

N68-34522# Institutt for Atomenergi, Halden (Norway). Reaktor Prosjekt.
COMPARATIVE STUDIES OF MATHEMATICAL HYDRODYNAMIC MODELS APPLIED TO SELECTED BOILING CHANNEL EXPERIMENTS
T. Bjoerlo, T. Eurola (Finnish AEC, Helsinki), R. Grumbach, P. Hansson (Aktiebolaget Atomenergi, Stockholm, Sweden), K. Romslo et al Dec. 1967 317 p refs
(HPR-97)

Mathematical models to investigate the dynamic behavior of boiling water channels connect the basic laws of conservation

of mass, momentum, and energy to empirical correlations for friction, slip ratio, subcooled boiling and heat transfer. Several different approaches are possible in assembling a theoretical model, and comparative studies have been undertaken in which various models were applied to selected experimental conditions. The comparisons between theoretical and experimental results have enabled conclusions to be drawn about the range of applicability of certain physical concepts and given the basis for a better understanding of the importance of several hydraulic parameters in the dynamic behavior of the coolant in a boiling channel. The comparisons between theoretical and experimental results included axial void distribution, void and mass flow in natural circulation as functions of the channel power, transfer functions, and stability limits. Furthermore, the models were compared to each other with respect to the mathematical description and the solution methods. A survey of the available experimental material was carried out which, together with the experience from the model studies, may serve as a guideline for future experiments in this field. Author (NSA)

N68-34590# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
A MODIFIED MOMENT APPROACH TO SOME PROBLEMS IN RAREFIED GASES
Prem K. Khosla Jun. 1968 35 p refs
(Contract NONR-839(34))
(PIBAL-68-16; AD-672544)

In the present report existing moment methods have been modified to incorporate correct initial and boundary conditions on the distribution function itself. The method is then applied to solve few representative problems. The modified form of Grads 13-moment equation as applied to shock wave structure leads to solutions for arbitrary Mach numbers and gives thicknesses comparable to those obtainable by some of the other methods. Author (TAB)

N68-34608# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
INVISCID BLUNT BODY SHOCH LAYERS. (TWO-DIMENSIONAL SYMMETRIC AND AXISYMMETRIC FLOWS)
Gino Moretti Jun. 1968 172 p refs
(Contract Nonr-839(34))
(PIBAL-68-15; AD-672543)

The results of a time-dependent computation of blunt body shock layers for two-dimensional symmetric and axisymmetric flows are presented in a systematic form for a range of values of the free stream Mach number and bodies of different shapes and variable bluntness. A brief discussion of the relevant features of the computational technique is given. The results are presented in a graphical form; the graphs were produced by the computer. Author (TAB)

N68-34624#
RESULTS OF COMPUTING THE GAS FLOW WITH PARTICLES IN AXISYMMETRIC NOZZLES BY THE METHOD OF CHARACTERISTICS AND COMPARISON WITH RESULTS OF A ONE-DIMENSIONAL APPROXIMATION
L. P. Vereshchaka, N. S. Galiun, A. N. Kraiko, and L. E. Sternin [1968] 8 p refs Transl. into ENGLISH from Izv. an SSSR, Mekh. Zhidk. i Gaza (USSR), no. 3, 1968 p 123–128
CFSTI: HC$3.00/MF$0.65

Results obtained by the method of characteristics are compared with those from a one-dimensional approximation for gas flow with particles in axisymmetric nozzles. Especially in the case of high relative particle discharges, errors in the one-dimensional approximation were found to be quite large. Difference between the exact and one-dimensional results was attributed to the presence of vertical velocity components, bifurcation of the stream into two domains, and nonuniformity in the distribution of the particles in the domain occupied by the particles. Greatest difference in corresponding parameters was at the nozzle wall. M.W.R.

N68-34627
TURBULENT MULTICOMPONENT BOUNDARY LAYER ON A PLATE
G. V. Kocheryzhenkov [1968] 7 p refs Transl. into ENGLISH from Gazodinamika i Teploobmen. (Leningrad), no. 1, 1968 p 74–81
CFSTI: HC$3.00/MF$0.65

Turbulent boundary layer is considered for a plate around which dissociated air or another gas mixture flows; and a coolant is passed through the pores on the plate surface. A solution is offered for the motion of an n-component frozen gas mixture in the boundary layer. Velocity profile determinations are made beginning with the turbulent analogs of the Prandtl and Lewis numbers, and attention is given to drag and friction laws. Surface temperature and values of the concentration at the wall are determined from the equations of heat and mass balance. M.W.R.

N68-34778# Nord-Aviation, Paris (France).
CALCULATION OF THE FIELDS AND TURBULENT FRICTION ON PLANAR PLATE BASED ON THE NAVIER STOKES EQUATION [ESSAI DE CALCUL DES CHAMPS ET FROTTEMENTS TURBULENTS SUR PLAQUE PLANE A PARTIR DES EQUATIONS DE NAVIER STOKES]
R. Hirsch Jan. 1968 7 p In FRENCH
(ARA-NT-2/68) CFSTI: HC$3.00/MF$0.65

The solution of the boundary layer problem by the Prandtl hypothesis is discussed, and the use of the Navier–Stokes for obtaining such solutions is proposed. It is shown that the first Navier–Stokes equation can be reduced to principal terms and that each of the kinematic terms in the second equation is negligible with regard to those retained in the first so that the values of the normal pressure gradient will be null. Compatibility is seen between the pressure field resulting from the kinematic equations and the theoretical inference of a correlation distribution of unstable components. Transl. by B.P.

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N68-33625# Danish Meteorological Inst., Charlottenlund.
OBSERVATION OF NATURALLY OCCURRING VLF AND MAN MADE HF PLASMA WAVES IN AURORAL REGIONS OF THE IONOSPHERE
T. S. Jorgensen and T. F. Bell Apr. 1968 24 p refs Presented at the NATO Advanced Study Inst. on Plasma Waves in Space and in the Lab., Roros, Norway, 17–26 Apr. 1968
(R-3) CFSTI: HC$3.00/MF$0.65

Satellites equipped with VLF and/or electron density experiments are suggested for use to determine the position of auroral oval. Particular emphasis is placed on correlating the electron density irregularities observed by Explorer 20 with the VLF hiss observed by OGO-2 to locate the auroral oval with high time-space resolution. Observations of VLF noise and topside soundings of electron densities in the ionosphere at auroral latitudes are reviewed. Specific data from Explorer 20 (at the lowest sounder frequency, 1.50 MHz, from high latitudes) and VLF observations by OGO-2 (in the space region where the midnight sector of the auroral oval

is located) are presented and analyzed. Preliminary evidence shows that hiss occurs in the regions of electron density irregularities because (1) both phenomena are observed at locations where auroral oval exists; (2) the areas occupied by hiss and irregularities are of the same size; (3) the small scale structure of the phenomena looks similar; and (4) the sharp low latitude hiss boundaries indicate ducting of the VLF energy. B.P.

N68-33631 Texas A&M Univ., College Station.
ANALYSIS OF THE METHODS OF PREDICTING HIGH CONCENTRATIONS OF AIR POLLUTANTS
Willard Rich Mc Daniel (Ph.D. Thesis) 1967 93 p
Available from Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-16465

The model used currently for predicting high levels of atmospheric particulate loads is shown to be inappropriate for the five-state area encompassing Texas, New Mexico, Oklahoma, Arkansas, and Louisiana. It is shown that within this region high pollution can exist even when upper-air winds are double the values prescribed in the national model. The importance of subsidence temperature inversions as a primary factor in incidents of high pollution is challenged. It is shown that pollution episodes can occur in any month, but summer occurrences cover a small geographical area and the particulate counts are low during this season. Vector statistics are employed to ascertain the climatology of the direction and speed of the surface and upper winds. The assumption of a circular wind distribution is proven to be invalid over the majority of the region. It is shown that high counts of suspended particulates can occur even when significant amounts of precipitation fall during the pollution episode. Dissert. Abstr.

N68-33666*# Southwest Center for Advanced Studies, Dallas, Tex.
SYSTEM FOR COLLECTING WORLD-WIDE LOWER THERMOSPHERE DATA
Francis S. Johnson [1967] 14 p refs Presented at Symp. on Meteorol. Invest. above 70 KM Am. Meteorol. Soc., Miami Beach, Fla., 31 May–2 Jun. 1967 Submitted for publication
(Grant NSG-269)
(NASA-CR-85641) CFSTI: HC $3.00/MF $0.65 CSCL 04A

To obtain lower thermospheric data on a world-wide basis, logistical considerations dictate that a satellite system be used rather than rockets. A pair of satellites is needed, with their orbits at right angles to one another (i.e., separated by six hours in local time), to give satisfactory time resolution. The orbits should have high inclination; 97° inclination (i.e., 83° retrograde) is desirable so that the local time of observation remains fixed as the orbits precess. As low an altitude should be utilized as is practical from the vehicle viewpoint (about 200 km if possible). The most important measurements are composition, airglow, and total density; a spinning satellite with its spin axis perpendicular to the orbit plane should be used to permit the determination of temperature from the shape of the response functions. Theoretical considerations must be used to extrapolate the measurements downward from the satellite altitude to the lower thermosphere; the theories should be checked and refined as necessary by use of altitude profiles obtained from sounding rockets. Author

N68-33840# RAND Corp., Santa Monica, Calif.
COMMENTS ON ATMOSPHERIC ICE MULTIPLICATION MECHANISMS
L. Randall Koenig Apr. 1968 10 p refs Presented at the 1968 Intern. Conf. on Cloud Phys., Toronto, Aug. 1968
(Contract NSF C-415)
(P-3830; PB-178501) CFSTI: HC $3.00/MF $0.65

Evidence supports the conclusion that some mechanism which occasionally is operative in the atmosphere results in ice-crystal concentrations that greatly exceed the concentration of ordinary ice-forming nuclei. No unique circumstances seem to set apart clouds that do and do not have an active crystal multiplication process, except that fairly large drops may be required for crystal multiplication. It is suggested that a mechanism involving the generation and breakage of whisker-like crystals on larger crystals that have become rimed by large droplets may be a mechanism for the copious production of new crystals. Author (USGRDR)

N68-33864*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STRATOSPHERIC TEMPERATURE PATTERNS DERIVED FROM NIMBUS 2 MEASUREMENTS
Guenter Warnecke and Andrew W. McCulloch Aug. 1967 19 p refs Presented at the 1967 COSPAR Meeting, London, 24–28 Jul. 1967 Submitted for publication
(NASA-TM-X-60427) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The Nimbus II medium resolution infrared radiometer (MRIR) experiment provided data for the period May 15 to July 29, 1966. The measurements within the 15 micron CO_2 absorption band were computer processed and printed in map form as polar stereographic and Mercator projections. The effect of middle and upper tropospheric cloud systems was eliminated by application of a correction model using the simultaneous measurements of the 10–11 micron window channel for the needed cloud top height information. Horizontal stratospheric temperature patterns that can be derived from these measurements cover the Northern Hemisphere in late spring and early summer as well as the Southern Hemisphere in late fall and early winter. The Northern Hemispheric stratosphere exhibits its stable summerly temperature regime; in the Southern Hemisphere, the stratospheric circulation is characterized by a continuous intensification of the cold polar vortex. The most striking phenomenon is an obvious asymmetry of the Southern Hemispheric temperature distribution with a warm cell moving cyclonically around the pole over the higher midlatitides during the first part of the period of measurement. This causes a remarkable asymmetry in the cooling pattern observed over the two-months period, the maximum cooling of 15°K being located at 55°–60° rather than over central Antarctica. Author

N68-33933# Finnish Meteorological Office, Helsinki.
MAGNETIC RESULTS FROM NURMIJARVI GEOPHYSICAL OBSERVATORY, 1967
1967 32 p
(Rept.-9) CFSTI: HC $3.00/MF $0.65

Declination, horizontal and vertical intensities, diurnal variations monthly means, and K and C indices for 1967 are tabulated from magnetic recordings made at the Nurmijarvi geophysical obeervatory in Finland. Annual means for 1953 through 1967 are also given. Located about 40 km northwest of Helsinki, the observatory has no nearby sources of artificial disturbance. M.W.R.

N68-33934# National Center for Atmospheric Research, Boulder, Colo.
OPERATIONAL LESSONS OF THE LINE ISLANDS EXPERIMENT
Aug. 1967 82 p Line Island Critique, Hawaii Univ., 5 May 1967 Sponsored by NSF
(NCAR-TN-30)

Comprehensive meteorological data of the tropics were collected in the Line Islands experiment conducted while the ATS-1 satellite was in orbit. Observations of standard meteorological parameters, made with conventional instrumentation, and still and motion photographs were made at the Line Islands, a group of small atolls more than 100 miles south of Hawaii. These were tied in with photographs taken by ATS-1, which was in synchronous orbit almost directly above the Line Islands. A general critique of the program is presented, with reports and discussions of the

committees on shipping and transportation, government coordination, site operations, and air operations. Actual data obtained during the experiment are not included. M.W.R.

N68-33935# National Center for Atmospheric Research, Boulder, Colo.
A SURVEY OF HAWAII FOR BALLOON LAUNCH SITES
Jack M. Angevine Aug. 1967 57 p refs Sponsored by NSF
(NCAR-TN-31)

Barking Sands Pacific Missile Range Facility on the island of Kauai and the Wheeler Air Force Base on Oahu were the two Hawaiian sites found to be suitable for the launching of a cable-restrained tandem balloon system initially laid out on the ground to a distance of 450 ft from payload, then raised to a height of 600 ft before its release. Ground anchors installed in a circle of 90-ft radius about the payload, handled by the double-anchor-line technique, would be required for the projected payloads of 10,000 lb with cross inflation of 17,000 lb. Available facilities, weather conditions, logistic problems, and living accommodations were considered; and initial contacts were made with FAA and other governmental agencies that would be involved in proposed launches. Major advantage of Braking Sands is that this site tracks missiles as an everyday activity, thereby assuring tracking of balloon flights with high accuracy. At Wheeler, virtually everything needed for a flight would have to be brought to the base. Other airfields surveyed had higher average winds, in high density traffic areas, too small, or too heavily trafficked. M.W.R.

N68-33943# Joint Publications Research Sercice, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NUMBER 186
22 Aug. 1968 110 p Transl. into ENGLISH from Russian
(JPRS-46258) CFSTI: HC$3.00/MF$0.65

Abstracts of scientific articles and summaries of new articles taken from the Soviet-bloc literature deal with geophysics, astronomy, and space. Both basic research and applications are reported; along with various conferences, launchings, and measurement techniques. Articles are listed under the general headings of astronomy, meteorology, oceanography, terrestrial geophysics, upper atmosphere and space research, and miscellaneous. M.W.R.

N68-33980# Bhabha Atomic Research Centre, Bombay (India). Nuclear Physics Div.
SOME COMPUTATIONS FOR DATA FROM LINEAR-CROSS SEISMIC ARRAYS
S. K. Arora 1967 27 p refs
(BARC-309) CFSTI: HC$3.00/MF$0.65

Standard tables for a combination of time lag along the two arms of the L-shaped Gauribidanur seismic array have been prepared block-wise to read directly the apparent signal velocity across the array and thereby enable direct estimates of epicentral distance and azimuth with respect to seismic events to be made. A wide range of 61 values of lags from −0.30 seconds to +0.30 seconds in steps of 10 milli-seconds are taken into account. These tables apply to all linear cross seismic arrays having a fixed spacing of 2.5 km between any two consecutive elements. In order to readily monitor a nuclear event, a table giving expected time-lags at Gauribidanur array for signals from certain known test zones is incorporated. Limitations on the application of these tables are also discussed. Author

N68-33983 California Univ., Los Angeles.
THE WORLD-WIDE DISTRIBUTION OF TIDES IN THE IONOSPHERE
Charles Merle Rush (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-14279

Records of hourly values of ionospheric parameters such as the critical frequencies of the F_2 and sporadic E layers and their respective heights are subjected to spectral analysis. It is found that the spectrum of the critical frequency of the F_2 layer in the frequency range 0 to 4 cycles per day consists of well identified lines which originate as a result of the tidal action of the sun and the moon. The most important of these lines represent oscillations with solar diurnal, solar semi-diurnal and lunar semi-diurnal periods. Mutual relationships of these tidal oscillations are studied as functions of solar epoch, geographical location, and season of the year by cross-spectral methods and by the method of harmonic analysis. Results of tidal analyses of geomagnetic data from 40 observatories throughout the world are given. The ionospheric and geomagnetic spectra are compared by cross spectre analysis. Dissert. Abstr.

N68-34058*# Oregon State Univ., Corvallis. Dept. of Chemistry.
RARE EARTH ABUNDANCES IN METEORITIC CHONDRULES
R. A. Schmitt, R. H. Smith, and D. A. Olehy [1967] 17 p refs Submitted for publication
(Contract NASw-943; Grant NGR-38-002-020)
(NASA-CR-84733) CFSTI: HC$3.00/MF$0.65 CSCL 08D

Summary data are given on an investigation in which radiochemical neutron activation analysis was used to determine the elemental abundance distribution of the 14 rare earth elements (REE) and yttrium (Y) in chondrules from Mokoia, Chainpur, Forest City, and Richardton. Tabulated data are included on absolute abundances, and a comparison is made of the normalized abundances of the 14 REE and Y in 20 chondritic meteorites. The ratios of the respective normalized values in the chondrules to average normalized values in 20n chondrites were plotted versus the ionic radii of the REE. B.S.D.

N68-34157*# Volt Technical Corp., Washington, D. C.
OVAL OF AURORA BOREALIS AND THE RING CURRENT IN THE EARTH'S MAGNETOSPHERE
A. D. Shevnin, Ya. I. Fel'dshteyn, and G. V. Starkov Greenbelt, Md. NASA. Goddard Space Flight Center 6 Sep. 1968 9 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), Vol. 6, No. 4, 1968 p 598–603
(Contract NAS5-12487)
(NASA-CR-96662; ST-PF-GM-10745) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Making use of Williams and Ness calculations, the position of the boundary of closed lines of force on the night side of the earth is computed and graphically presented, as a function of the field in the magnetosphere tail and of the ring current value. Observations of the southern boundary of the aurora oval allowed a direct determination of the magnetic flux of the ring current. The same flux is calculated as a function of ring current parameters in the Akasofu and Cain model. Comparison of the results of calculations leads to the conclusion that during magnetic storms the ring current is at a distance of ≈ 3–3.5 Earth's radii. With the increase of the ring current field, the proton belt increases at the expense of the withdrawal of its outer boundary and a redistribution (increase) of the pitch-angles takes place. Author

N68-34232*# Columbia Univ., New York.
A FIVE COLOUR PHOTOMETRY AND POLARIMETRY OF THE ZODIACAL LIGHT: A PRELIMINARY REPORT
R. D. Wolstencroft and J. C. Brandt (NASA. Goddard Space Flight Center) [1967] 23 p refs Presented at the Zodiacal Light and the Interplanetary Medium Conf., I.A.U.: Honolulu, Hawaii, 30 Jan.–2 Feb. 1967
(Grant NGR-33-008-053)
(NASA-CR-83189) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Simultaneous observations in five colors of the brightness and state of polarization of the night sky radiation were secured from Mount Chacaltaya, Bolivia, during July and August 1964. The spectral range was from 3650 to 9515Å. The results of a preliminary analysis of part of this data are presented: these include a description of the wavelength dependence of the zodiacal light brightness and polarization, possible complicating emissions from the atmosphere, and some remarks concerning circular polarization of the radiation scattered by dust. Author

N68-34261*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

OBSERVATIONS OF SEA SURFACE TEMPERATURES AND OCEAN CURRENTS FROM NIMBUS 2

Guenter Warnecke, Lewis J. Allison, and Lonnie L. Foshee Aug. 1967 14 p ref Presented at the COSPAR 10th Plenary Meeting, London, 24–29 Jul. 1967 Submitted for publication

(NASA-TM-X-60412) CFSTI: HC$3.00/MF$0.65 CSCL 04B

Radiometric high resolution infrared measurements recorded by the Nimbus II meteorological satellite in the 3.4–4.2 atmospheric window region yielded a complete and detailed global mapping of equivalent blackbody temperatures for a 6 month period. Under clear sky conditions, surface temperatures can be determined within an accuracy of ± 1 to 2°K if corrections of 1 to 5°K are applied for residual absorption by atmospheric water vapor and carbon dioxide, depending on the atmospheric composition and scan nadir angle. A good agreement exists between the satellite measurements and sea surface temperature measurements from aircraft and ships. Of particular interest in this investigation was the usefulness of these infrared measurements for the detection of sea surface temperature discontinuities. During the 174 days of Nimbus II high resolution infrared measurements, the Gulf Stream north wall could be seen at least in part in about 50 cases. Other ocean currents such as the Falkland and Brazil Currents, the Agulhas Current and the Kuro Shio could also be detected; and their respective sea surface temperatures were determined. Author

N68-34334# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

SHORT LIVED COSMIC RAY PRODUCED RADIONUCLIDES AS TRACERS OF ATMOSPHERIC PROCESSES

James A. Young, Ned A. Wogman, Charles W. Thomas, and Richard W. Perkins 1 Apr. 1968 21 p refs Presented at the 155th Natl. Meeting of the Am. Chem. Soc., San Francisco

(Contract AT(45-1)-1830)

(BNWL-SA-1741; CONF-680308-10) CFSTI: HC$3.00/MF$0.65

Measurements of radionuclide concentrations in both air and rain water are described. Their use in describing atmospheric mixing and precipitation processes is discussed. NSA

N68-34411*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

A DIRECT MEASUREMENT OF ION COMPOSITION AND CONCENTRATION IN THE DAYTIME F_2-REGION

H. C. Brinton, M. W. Pharo, III, H. G. Mayr, and H. A. Taylor, Jr. Aug. 1968 34 p refs

(NASA-TM-X-63326; X-621-68-329) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The positive ion mass spectrometer on the Geoprobe (NASA 8.25) rocket measured the concentrations of O^+, N^+, H^+, He^+, NO^+, O_2^+ and N_2^+ between 200 km and peak altitude, 630 km, at 1300 EST on March 2, 1966 above Wallops Island, Virgina. O^+ was the dominant ion throughout the altitude range, reaching a maximum concentration of 5×10^5 ions/cm^3 at 260 km. H^+ was first detected at 230 km and increased in concentration to 7×10^3 ions/cm^3 at peak altitude. The H^+/He^+ ratio was never lower than 6.0, the value at 420 km. NO^+ and O_2^+ were important constituents at 200 km, the concentration of each being 5×10^4 ions/cm^3; they fell off rapidly above this altitude. He^+ was in photochemical equilibrium up to 400 km with a rate coefficient of $\approx 0.5 \times 10^{-9}$ cm^{3}sec^{-1} for charge transfer with N_2, in agreement with laboratory measurement. H^+ was in charge exchange equilibrium with O^+, O, and H up to 450 km; the temperature derived for the neutrals in both the He^+ and H^+ chemistry was 750°K, which agrees with T_g measured by companion neutral particle sensors. From the variation of $[H^+]/[O^+]$ and an [O] distribution based on a simultaneous EUV measurement, a profile of [H] in the chemical equilibrium region was calculated. Author

N68-34468# Stanford Research Inst., Menlo Park, Calif.

IONOSPHERIC AND MAGNETIC OBSERVATION AT BANGKOK, THAILAND DURING THE ANNULAR SOLAR ECLIPSE ON NOVEMBER 23, 1965

Jan E. van der Laan Dec. 1967 31 p refs

(Contract DA-36-039-AMC-00040(E); ARPA Order 371)

(STR-32; AD-672068)

Vertical-incidence ionospheric measurements and magnetograms, made during the annular solar eclipse of November 23, 1965, are presented and discussed. A marked change in the F2-layer virtual height and considerable stratification of the F layer were observed, including formation of an F1.5 layer. The magnetograms indicate a large (approximately 25 percent) diminution relative to the normal solar disk was observed at about 1009 hours local time (0309 GMT) at Bangkok, which was approximately 290 km from the center of the eclipse path. Author (TAB)

N68-34469# California Univ., Los Angeles. Dept. of Meteorology.

COLORIMETRIC DESCRIPTION OF RADIATION EMERGING FROM THE TOP OF A RAYLEIGH ATMOSPHERE

C. R. Nagaraja Rao Apr. 1968 22 p refs

(Contract F19628-67-C-0196)

(AFCRL-68-0090; SR-2; AD-672308)

The trichromatic coefficients of light emerging from the top of a plane parallel, purely scattering Rayleigh (molecular) atmosphere have been computed. The extraterrestrial illumination from the sun is approximated with illumination from the CIE standard illuminant C. The ground is assumed to reflect radiation according to the Lambert law. The results are expressed in terms of the dominant wavelength and associated values of excitation purity. It is found that when the diffuse reflectivity of the ground assumes moderate to high values (0.25 to 0.8), the excitation purity of the emergent light is so small as to cause an overall neutral grey or neutral white appearance. On the other hand when the ground is non reflecting or when the diffuse reflectivity is very low, the dominant wavelength of the emergent radiation lies in the blue region and the associated excitation purity exhibits fairly high values (40%). It is possible that computations such as the above, when extended to more realistic models of the atmosphere, may find application in problems related to color-photographic reconnaissance from high altitudes. Author (TAB)

N68-34493*# Southwest Center for Advanced Studies, Dallas, Tex.

COMPOSITION CHANGES IN THE LOWER THERMOSPHERE

Francis S. Johnson and B. Gottlieb (Bishop Coll., Dallas) May 1968 9 p refs Presented at COSPAR 11th Ann. Meeting, Tokyo, 9–21 May 1968

(Grant NsG-269)

(NASA-CR-96815) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The upper atmosphere over the winter polar region remains about as warm as that at low latitudes. The most likely heat source in the thermosphere and mesosphere to maintain this warmth is thought to be subsidence, and its rate can be estimated by equating the compressional heating to the normal rate of solar heat input at low latitudes. The average rate of inflow into the polar

region required to produce this subsidence can also be calculated. Further, just above the turbopause, the inflow of different constituents is proportional to the product of the concentration and the scale height, whereas the loss by motion downward is proportional to the concentration but independent of the scale height; this effect leads to a concentration of the lighter constituents in the thermosphere over the winter polar region. This is observable in terms of the helium bulge over the winter polar region, and it should also lead to an increase in oxygen concentration. These effects may be enhanced when there is sudden breakdown of the polar vortex. Author

N68-34556# RAND Corp., Santa Monica, Calif.
THEORY OF HYDROMAGNETIC PROPAGATION IN THE IONOSPHERIC WAVEGUIDE
Carl Greifinger and Phyllis Greifinger Jun. 1968 60 p refs
Sponsored by AF and ARPA
(RM-5616; AD-672252)

A study of the propagation of low frequency hydromagnetic waves in an ionospheric duct centered around the Alfven speed minimum near the F2 ionization peak. An inhomogeneous waveguide is considered in the presence of a uniform magnetic field, the case treated being that of horizontal propagation in the plane of the magnetic meridian. It is shown that each band has a low frequency cutoff and that the existence of such a cutoff is a consequence of the boundary conditions rather than of attenuation. Numerical solutions of the dispersion equation are obtained for the two lowest bands for each of the conditions considered. Author (TAB)

N68-34559# Ohio State Univ. Research Foundation, Columbus. Geodetic Science Dept.
INTERPOLATION OF DEFLECTIONS FROM HORIZONTAL GRAVITY GRADIENTS Final Report, Oct. 1966–Dec. 1967
John Badekas and Ivan I. Mueller Dec. 1967 92 p refs
(Contract DA-44-009-AMC-507(X))
(Rept.-98; AD-672490)

The report gives the computational processor and the results of a test on the interpolation of deflections from horizontal gravity gradients measured by means of a torsion balance. First, the theory of such an interpolation is given together with the description of the associated computer program. Next, the observed data is analyzed and variances are computed or estimated. Finally, interpolations are performed in single or multiple lines and with the results a detailed local geoid map is compared with the latest astrogeodetic geoid map of the US Army Map Service. The conclusion is that with the torsion balance deflections can be interpolated to accuracies of about 0.5 seconds for lines 30-40 km long. Author (TAB)

N68-34573# Ohio State Univ., Columbus. Dept. of Geodetic Science.
THE HORIZONTAL GRADIENTS OF GRAVITY IN SOUTHWEST OHIO
John Badekas Sep. 1968 206 p refs
(Contract DA-44-009-AMC-507(K))
(Rept.-89; AD-672489)

This report gives the results of torsion balance observations made in Southwest Ohio during the period June through November, 1966. The main parts of the torsion balance and the observation procedure are described. The computation of the variance of the observations, the gradients, and the effects of the topography (terrain, topographic, and cartographic effects), together with the results, are included. A description and the statement listing of the computer programs used are given. Author (TAB)

N68-34589# Ohio State Univ. Research Foundation, Columbus. Geodetic Science Dept.
GEODETIC CONTROL BY MEANS OF ASTRONOMIC AND TORSION BALANCE OBSERVATIONS, AND THE GRAVIMETRIC REDUCTION OF LEVELING Final Report, Mar. 1964–Dec. 1967
Ivan I. Mueller, John Badekas, and Edward J. Krakiwsky Jan. 1968 42 p refs
(Contract DA-44-009-AMC-507(X); Proj. OSURF 1802)
(Rept.-99; AD-672491)

The report contains a summary of the findings in detail in the following reports of the Department of Geodetic Science: No. 60 Systems of Height, No. 61 Astro-Geodetic Deflections in Southwest Ohio, No. 72 Proposed Establishment of a First-Order Height System in the U.S.A., No. 89 The Horizontal Gradients of Gravity in Southwest Ohio, No. 98 Interpolation of Deflections from Horizontal Gravity Gradients. Author (TAB)

N68-34639# Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
CALCULATED SPECIFIC YIELD FUNCTIONS FOR NEUTRON MONITORS Final Report, 15 May 1967–14 May 1968
Kendle M. Wainio, Theodore H. Colvin, Keith A. More, and Otho L. Riffany Jun. 1968 40 p refs
(Contract F19628-67-C-0367)
(BSR-2302; AFCRL-68-0320; AD-672313)

Results of calculations to determine specific yield functions for IGY neutron monitors are reported for vertically incident protons in the range of 0.5 to 3 Gv/c. The Monte Carlo method is used to calculate secondary nucleon flux intensities at various depths in the atmosphere. Experimental data on neutron monitor response are employed to relate the calculated flux data to count rates and hence to specific yields. The specific yield function was also calculated as a function of the angle of incidence of the primary cosmic ray flux. The results show that a significant fraction of counts in a neutron monitor is produced by particles incident from directions other than the vertical. Author (TAB)

N68-34646# Stanford Univ., Calif. Radioscience Lab.
VLF EMMISSIONS
R. A. Helliwell [1968] 14 p refs

The properties of VLF emissions emanating from the magnetosphere are reviewed and their interpretation is discussed. Attention is centered on emission phenomena occurring at frequencies below the electron gyrofrequency, and only those phenomena which appear to generate propagating waves that can be observed on the ground or in satellites are treated. Auroral hiss and discrete emissions with associated hiss are considered. Natural and man-made events are examined for their role in triggering emissions. In the interpretation of emissions, emphasis is on the longitudinal and transverse resonances between electrons and electromagnetic waves propagating in the whistler mode. K.W.

N68-34680*# Southwest Center for Advanced Studies, Dallas, Tex.
DEVELOPMENTS IN UPPER ATMOSPHERIC SCIENCE DURING THE IQSY
Francis S. Johnson [1967] 32 p refs Presented at the Symp. on the Years of the Quiet Sun–IQSY, Natl. Acad. of Sci., 104th Ann. Meeting, Washington, D. C., 24–27 Apr. 1967 Submitted for Publication
(Grant NsG-269)
(NASA-CR-86846) CFSTI: HC $3.00/MF $0.65 CSCL 04A

It is shown that the vertical structure of the atmosphere is to a large degree controlled by its temperature distribution and that the largest temperature variations occur above 200-km altitude. Sudden drops in electron and ion concentrations in the ionosphere and magnetosphere are attributed to a persistent wind pattern in the upper atmosphere and plasma drift caused by an electric field. The formation of the equatorial anomaly in the F region, the persistence of the F region at night, and the mid-latitude sporadic E

layers are attributed to electric field effects and ion recombinations. Ion whistlers are identified as signals propagating below the ion gyro frequency in a left-handed polarized mode. G.G.

N68-34689*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NASA-LRC PROGRAM TO DEFINE EXPERIMENTALLY THE EARTH'S IR HORIZON
J. A. Dodgen, T. B. McKee, and A. Jalink [1967] 28 p refs Presented at the Symp. on Infrared Horizon Sensors for Spacecraft Guidance and Control, El Segundo, Calif., 14–15 Mar. 1967
(NASA-TM-X-61208) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Flight results are reviewed on the experiments conducted to obtain radiance profile measurements in the spectral intervals considered most promising for horizon sensor use, and to provide experimental verification of analytical IR radiance profile synthesis techniques. The Project Scanner flight experiment, a suborbital ballistic rocket vehicle fired to an altitude of 700 km, indicated: (1) The 15μ CO_2 band is superior to the water vapor band for horizon sensor use due to the reduced effects of clouds and local weather anomalies. (2) The measurements obtained in this band verify the radiance profile synthesis techniques employed within Project Scanner measurement accuracy. The synthesized radiance profiles may therefore be used to 50 km tangent heights were meteorological data are available. (3) The analytical profile synthesis technique is useful for studying design approaches to, and accuracy of, high presision horizon sensors. An overview is presented on the X-15 horizon radiometer flight experiment, and a summary is included on the study results of the Earth Coverage IR Horizon Measurement Program. M.G.J.

N68-34720# Raytheon Co., Alexandria, Va. Autometric Operation.
DATA WEIGHTING ANALYSIS Final Report, 1967–1968
Gordon Gracie, Robert B. McEwen, John Kenefick, and John Wang Jun. 1968 122 p refs
(Contract DAAK-02-67-C-0592)
(AD-672101)

The objective of the investigation was to determine what effect the weighting of observed data has on the accuracy of MUSAT aerotriangulation results. In the MUSAT program it is possible to weight three different sets of observations: image coordinates, camera parameters, and ground control coordinates. Often, the weights assigned for the aerotriangulation are only estimates and, as such, they may improperly reflect the actual accuracies of the observations. In order to determine the overall effect of improper weighting of observations, this investigation is conducted under carefully controlled conditions using only fictitious data. A clear distinction is maintained between generated weight levels used to randomly perturb the theoretically correct observations and the assigned weight levels used in the MUSAT aerotriangulation program. The two quantities relied upon for reporting results are the RMS values and the propagated standard deviations of the ground coordinates. The RMS values are shown to be primarily dependent on the generated weight levels while the propagated standard deviations are only a function of assigned weight levels. Thus, in general, improper weight assignment will affect aerotriangulation results only slightly. However, without correct weight assignment, the error propagation results will be incorrect. Author (TAB)

N68-34804# Alaska Univ., College. Geophysical Inst.
QSY ASCAPLOTS FROM 20 U.S. ALL-SKY CAMERA STATIONS Final Report, 1 Jul. 1964–15 Nov. 1967
M. J. Young 15 Nov. 1967 37 p
(Grant NSF GA-318)
(UAG-R-205)

During the 1964–1965 International Quiet Sun Year, twenty U.S. All-Sky cameras operated. The camera films were reduced to ascaplots for comparison of auroral activity with the International Geophysical Year/International Geophysical Cooperation period. Time intervals, weather, and sky divisions are plotted on the ascaplots. The ascaplots, lists of stations, and an auroral index for data reduction are included. B.P.

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N68-33640*# Battelle Memorial Inst., Columbus, Ohio.
RESONANT SYSTEMS FOR DYNAMIC TRANSDUCER EVALUATIONS Final Report
R. E. Robinson and C. Y. Liu 31 Aug. 1968 53 p refs
(Contract NASr-100(08))
(NASA-CR-72435) CFSTI: HC $3.00 CSCL 14B

A study of methods for generating large amplitude, high frequency dynamic pressures at high static pressures such as those encountered in rocket motor combustion instability studies was performed. An analytical and experimental program was undertaken to evaluate the most promising concept, an inlet-modulated, gas throttled device (siren type), for pressure transducer evaluations. Author

N68-33839# LTV Electrosystems, Inc., Greenville, Tex.
ELECTRO-OPTICAL SENSOR ANALYSIS
Sep. 1968 19 p
(G3685.20.03A)

A technique for analyzing or forecasting the performance of electro-optical sensors permits the evaluation of the effectiveness of the sensors prior to hardware testing. An example of an analysis of a hypothetical forward-looking-infrared (FLIR) system is given to show the effect of differences in design parameters. The analysis includes a consideration of the observer-display relationship. A mathematical model of a low-light-level-television (LLLTV) system is also described. This model has been formed to provide information regarding probability of detection of targets. It includes routines to handle the effects of relative image motion, atmospheric transmission degradation, target illumination, and performance parameters of various components of the sensor. Author

N68-33895 Ohio State Univ., Columbus.
CALIBRATION OF THE AERIAL PHOTOGRAPHIC SYSTEM
Dean Charles Merchant (Ph.D. Thesis) 1967 134 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-16308

Emphasis on greater accuracy from photogrammetric methods has stimulated interest in the problem of calibration of the aerial photographic system. To be realistic, the calibration procedures must be accomplished under circumstances of environment and technique which are equivalent to those to be expected operationally. It was the purpose of this study to develop and investigate the feasibility of providing a realistic aerial photographic system calibration. Computational procedures were developed, programmed and verified with artificial data. These computations included comparator calibration, single photo resection and multiple photo resection. The multiple photo resection employed up to four photographs using a common six parameter model to express interior orientation. All procedures were verified further by use of real photography made at 14,000 feet over the U. S. Coast and Geodetic Survey, McClure, Ohio camera calibration range. Dissert. Abstr.

N68-33931# Bhabha Atomic Research Centre, Bombay (India) Nuclear Physics Div.

STUDIES ON A SPLIT-POLE MAGNETIC SPECTROGRAPH

M. N. Viswesvariah and N. Sarma 1968 43 p refs

(BARC-326) CFSTI: HC $3.00/MF $0.65

A first order theory for the performance of a split-pole magnetic spectrograph is presented; and the median plane image distance and magnification, dispersion and moment resolution, and vertical magnification kinetic correction are among the ion properties considered. The spectrograph employs both circular and straight sector magnets, and these sectors are separated by a boundary called the split. Characteristics and construction details are included and variation of momentum resolution with change in source distance is detailed. M.W.R.

N68-34021 Du Pont de Nemours (E. I.) and Co., Wilmington, Del.

A TOTAL REFLECTION X-RAY SPECTROGRAPH FOR FLUORESCENT ANALYSIS OF LIGHT ELEMENTS

R. H. Davies and H. K. Herglotz 24 Jul. 1968 14 p refs

A novel X-ray spectrograph for the analysis of light elements has been developed based on previous computations and confirming experiments by one of us (H. K. Herglotz). The major components of the instrument are an efficient fluorescent source, a totally reflecting mirror, and an open window photomultiplier. Identification of wavelengths in the range $15 < \lambda < 80$ Å is achieved by the wavelength dependence of the critical angle of reflection of an X-ray beam incident on a suitably chosen low absorption reflector. As the incident angle is increased through the critical angle for a particular wavelength, the reflected beam intensity is sharply reduced; hence, a periodic vibration of the incident beam through a small angular range about the critical angle furnishes a strong a.c. reflected signal characteristic of one narrow wavelength band only. Initial results promise a simple, easy-to-operate instrument for the routine analysis of elements boron to fluorine. Author

N68-34057# Bhabha Atomic Research Centre, Bombay (India). Health Physics Div.

DESIGN OF PROTON RECOIL COUNTERS WITH MULTIPLE RADIATORS

G. Muthukrishnan, K. B. S. Murthy, and C. M. Sunta 1968 26 p refs

(BARC-330) CFSTI: HC $3.00/MF $0.65

Two types of counters for fast neutron dosimetry and for neutron flux measurement have been developed using a proportional counter with multiple proton radiators. Calculations have been done for the counter response using CDC 3600-160A computer for polythene radiators of thickness varying from 0.01 mm to 3 mm and for incident neutron energies from 0.3 to 16 Mev. These computations along with that of the burshane gas response are used to select the pressure of the gas, thickness of the solid radiators and the proportions of their areas such that the overall response of the counter is as close to the desired response as possible. The energy response of the counters is experimentally studied using monoenergetic neutrons. The experimental and the calculated responses are in good agreement. Author

N68-34099# National Physical Lab., Teddington (England). Metrology Centre.

A CORRECTION TO THE CONSTANT FOR MASTER VISCOMETERS ON ACCOUNT OF SURFACE TENSION

J. E. Daborn May 1968 14 p refs

(NPL-MC-1) CFSTI: HC $3.00/MF $0.65

In order to determine the effects of surface tension on viscosity measurements, experiments were carried out with U-tube viscometers of new design and the results were compared with those obtained from conventional ones. It was found that there was a real difference between the performance of the two types of viscometer although it was much smaller than supposed. ESRO

N68-34115# World Meteorological Organization, Geneva (Switzerland).

PRECISION OF PYRHELIOMETRIC MEASUREMENTS [PRECISIONS DES MESURES PYRHELIOMETRIQUES]

1967 131 p refs In FRENCH and ENGLISH Presented at the 3rd Session of the Radiation Working Group of the 6th Regional Assoc., Brussels, 23–27 May 1966 *Its* NT-85

(OMM-209-TP-109) CFSTI: HC $3.00/MF $0.65

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7. AUTOMATIC COMPENSATION FOR THE HEATING OF METAL STRIPS OF THE ANGSTROM PRYRHELIOMETER D. Crommelijnck and W. Vandenborre (Inst. Roy. Meteorol. de Belgique) p 65-68 (See N68-34122 21-14)

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9. ON THE EFFECT AND IDENTIFICATION OF ACCIDENTAL ERROR IN SIMPLE AND SIMULTANEOUS MEASUREMENT SERIES R. Sneyers (Inst. Roy. Meteorol. de Belgique) p 93-102 refs (See N68-34124 21-19)

10. EFFORTS MADE TO BASE PHOTOMETRY ON ABSOLUTE RADIOMETRY L. Morren (Louvain Univ.) p 107-111 (See N68-34125 21-14)

11. A CONTRIBUTION TO THE STUDY OF AN ABSOLUTE RADIOMETER: CHARACTERISTICS OF AN EXPERIMENTAL PROTOTYPE D. Crommelijnck (Inst. Roy. Meteorol. de Belgique) p 113-123 (See N68-34126 21-14)

12. THE PROBLEM OF A PYRHELIOMETRIC REFERENCE SCALE FOR WORLD RADIOMETRIC CENTERS M. C. Perrin de Brichambaut (Observ. Teisserance de Bort.) p 125-128 (See N68-34127 21-14)

N68-34116# World Meteorological Organization, Geneva (Switzerland).

ON THE ATMOSPHERIC TURBIDITY AND ITS BEARING UPON PYRHELIOMETRIC MEASUREMENTS

Anders Angström *In Its* Precision of Pyrheliometric Meas. 1967 p 3-5 ref (See N68-34115 21-14)

Solar radiation measurements depend on both aperture of the instrument and the turbidity of the atmosphere. The value of additional sky radiation due to the turbidity is discussed. It is

shown that parameters which up to now have been suggested are of value for determining corrections of first order but further theoretical and experimental studies will lead to improvements. ESRO

N68-34117# Institut d'Aéronomie Spatiale de Belgique, Brussels.
CHARACTERISTIC GEOMETRICAL FUNCTION OF ANGSTROM PYRHELIOMETER NO. 210 AT DAVOS [FONCTION CARACTERISTIQUE GEOMETRIQUE DU PYRHELIOMETRE D'ANGSTROEM NO. 210 DE DAVOS]
R. Pastiels *In* WMO Precision of Pyrheliometric Meas. 1967 p 7-21 refs In FRENCH; ENGLISH summary (See N68-34115 21-14)

Complete calculation of the characteristic geometric function of the Davos K. Angström pyrheliometer No. 210 for two systems of diaphragms by which it has been used as international standard. Author (ESRO)

N68-34119# Swedish Meteorological and Hydrological Inst., Stockholm.
PYRHELIOMETRIC MEASUREMENTS WITH SPECIAL REGARD TO THE CIRCUMSOLAR SKY RADIATION
B. Rodhe *In* WMO Precision of Pyrheliometric Meas. 1967 p 29-34 refs (See N68-34115 21-14)

Comparison made with different pyrheliometers at different locations has shown the role of atmospheric turbidity. The influence of instrument aperture and of the filter holder are discussed. Some principles are laid down concerning calibration and standardization of pyrheliometers. ESRO

N68-34120# Basel Univ. (Switzerland). Astronomical and Meteorological Inst.
THE INFLUENCE OF ATMOSPHERIC TURBIDITY ON THE CALIBRATION OF PYRHELIOMETERS
W. Schüepp *In* WMO Precision of Pyrheliometric Meas. 1967 p 35-48 refs (See N68-34115 21-14)

Measurements of circumsolar radiation have been attempted but experiments show that they were not accurate. In order to gain better knowledge of the scattering function general principles are laid down and application of the theory of diffusion by aerosol based on the Mie formula is made and consequences for pyrheliometric comparisons and calibration are drawn. ESRO

N68-34121# Meteorological Observatory, Potsdam (East Germany).
RESULTS OF PYRHELIOMETER COMPARISONS MADE IN POTSDAM WITH REGARD TO RECENT INVESTIGATIONS ON THE INFLUENCE OF CIRCUMSOLAR SKY RADIATION
W. Schöne *In* WMO Precision of Pyrheliometric Meas. 1967 p 49-61 refs (See N68-34115 21-14)

The purpose of this study is to find out to what extent the results of comparative measurements of the compensation pyrheliometer Å 140''' with the silver-disk pyrheliometer S.I. 12 (or the Linke-Feussner actinometer No. 27, respectively) depend on the circumsolar sky radiation which is characterized by $m\beta$. For the investigation a total of 38 series of the period 1957 to 1962 are available for comparison. With 23 observational series the Å 140''' had a short tube, and with 15 series a long one was used. The results are compared with theoretical calculations made by Angström and Rodhe and with those by Schüepp. While by the Angström-Rodhe method for the variation of the ratio of the intensities greater values are obtained as a function of $m\beta$, there is a fairly good agreement between the results after Schüepp and the Potsdam measurements. Author (ESRO)

N68-34122# Institut Royal Météorologique de Belgique, Brussels.
AUTOMATIC COMPENSATION FOR THE HEATING OF METAL STRIPS OF THE ANGSTROM PYRHELIOMETER [COMPENSATION AUTOMATIQUE DE CHAUFFAGE DES LAMELLES DES PYRHELIOMETRES DU TYPE ANGSTROM]
D. Crommelijnck and W. Vandenborre *In* WMO Precision of Pyrheliometric Meas. 1967 p 65-68 In FRENCH (See N68-34115 21-14)

Automatization of measurements with pyrheliometers might be necessary for long duration observations. An automatic strip heating compensation device is described. ESRO

N68-34123# Institut Royal Météorologique de Belgique, Brussels.
A CONTRIBUTION TO THE STUDY OF COMPENSATED PYRHELIOMETERS. STUDY OF THE SOURCES OF DISSYMMETRY AND THEIR CONSEQUENCES ON MEASUREMENTS [CONTRIBUTION A L'ETUDE DES PYRHELIOMETRES A COMPENSATION. ETUDE DES SOURCES DE DISSYMMETRIE ET DE LEURS CONSEQUENCES SUR LES MESURES]
D. Crommelijnck *In* WMO Precision of Pyrheliometric Meas. 1967 p 69-90 refs In FRENCH (See N68-34115 21-14)

Pyrheliometric measurements rely on balancing thermal energy received by an irradiated strip and electric energy feed to the shaded strip. Although the two parts of the instrument are built as symmetric as possible, the balance between two energies of a different kind and the different thermal conductibility of material lead to dissymetries which are analyzed. Attention is drawn on the consequences on the accuracy of measurements and a proper method is indicated. ESRO

N68-34125# Louvain Univ. (Belgium)
EFFORTS MADE TO BASE PHOTOMETRY ON ABSOLUTE RADIOMETRY [EFFORTS ENTREPRIS EN VUE DE BASER LA PHOTOMETRIE SUR LA RADIOMETRIE ABSOLUE]
L. Morren *In* WMO Precision of Pyrheliometric Meas. 1967 p 107-111 In FRENCH (See N68-34115 21-14)

Researches are described which were made to define a better unity of luminance, particularly those carried out by the National Physical Laboratory where the Angstro A1m type pyrheliometer has been improved but had not yet led to a valuable standard. ESRO

N68-34126# Institut Royal Météorologique de Belgique, Brussels.
A CONTRIBUTION TO THE STUDY OF AN ABSOLUTE RADIOMETER: CHARACTERISTICS OF AN EXPERIMENTAL PROTOTYPE [CONTRIBUTION A L'ETUDE D'UN RADIOMETRE ABSOLU: CARACTERISTIQUES D'UN PROTOTYPE EXPERIMENTAL]
D. Crommelijnck *In* WMO Precision of Pyrheliometric Meas. 1967 p 113-123 In FRENCH (See N68-34115 21-14)

An absolute radiometer intended to measure with great accuracy the light energy and to act as a primary worldwide standard is described. ESRO

N68-34127# Observatoire Teisserenc de Bort (France).
THE PROBLEM OF A PYRHELIOMETRIC REFERENCE SCALE FOR WORLD RADIOMETRIC CENTERS [LE PROBLEME DE L'ETALON PYRHELIOMETRIQUE DE REFERENCE POUR LES CENTRES RADIOMETRIQUES MONDIAUX]
M. C. Perrin de Brichambaut *In* WMO Precision of Pyrheliometric Meas. 1967 p 125-130 In FRENCH (See N68-34115 21-14)

The problem of a pyrheliometric standard is discussed. Conditions for accurate measurement are laid down and reasons for the lack of reliability of present measures explained. Before an international pyrheliometric scale can be defined many improvements of the present method must be made. ESRO

N68-34132# Centre National d'Etudes Spatiales, Brétigny-sur-Orge (France).
MAGNETIC TAPE RECORDERS AND PLAYBACK OF MAGNETIC TAPES FOR GROUND BASE STORAGE OF

TELEMETRY DATA [LES ENREGISTREURS MAGNETIQUES LECTEURS DE DONNEES UTILISES POUR LE STOCKAGE AU SOL DES TELEMESURES BRUTES]
J.-C. Courteille Mar. 1967 84 p In FRENCH Presented at the School on the Technol. of Space Expt. Sponsored by CNES
CFSTI: HC$3.00/MF$0.65

Basic principles of recording are explained and playback instruments used for the storage of telemetry data are reviewed. Different processes of data recording are discussed. A description is given of tape recorders. Different types of tape used are analyzed. ESRO

N68-34170# Centre National de la Recherche Scientifique, Marseilles (France). Laboratoire d'Astronomie Spatiale.
ANALYSIS OF MULTIDIMENSIONAL INFORMATION ON ASTRONOMICAL PHOTOGRAPHS [ANALYSE DE L'INFORMATION MULTIDIMENSIONNELLE DES CLICHES ASTRONOMIQUES]
J. M. Deharveng *In its* Summer School, Strasbourg, 3-7 Jul. 1967 25 p refs In FRENCH (See N68-34168 21-23)

Fabry's photographic method can be used for a variety of applications thanks to multilenses giving a screened image on the photographic plate. With a screen of lenses, each lense having an aperture greater than that of the telescope, it is possible to concentrate on a small field of the photographic plate the part of information included in the screen field. The problem is discussed as to its sensitivity, its figure of merit and signal to noise ratio. The restitution of the received signal is explained. ESRO

N68-34197# Fluggerätewerk Bodensee G.m.b.H., Überlingen (West Germany).
EFFECT OF STOCHASTIC DISTURBANCES ON THE BEHAVIOR OF A STABILIZED PLATFORM WITH GAS BEARING GYROS AS SENSORS [AUSWIRKUNG STOCHASTISCHER STORUNGEN AUF DAS VERHALTEN EINER KREISELSTABILISIERTEN PLATTFORM MIT GASGELAGERTEN KREISELN ALS MESSFUHLER]
U. Krogmann May 1968 61 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMWF-FBW-68-36) CFSTI: HC$3.00/MF$0.65

The fundamentals of random theory are summarized as far as they are needed within the scope of this article. In order to examine the influence of random inputs on the behavior of the single axis platform, it is simulated on an electronic analog computer. A suitable spectrum of the random disturbing variable is determined and derived from the 'white noise source' accommodated in the analog computer by a proper shaping filter. The system is analyzed taking into account two different networks of the platform electronics, and the stochastic optimum is determined. It can be seen that this optimum is far away from the deterministic optimum. Therefore the system is adjusted in the proper sense to attain a compromise between the stochastic and deterministic optimum. Author (ESRO)

N68-34235# Joint Publications Research Service, Washington, D. C.
SYSTEMATIC ERRORS OF ASTROMETRIC INSTRUMENTS
14 Aug. 1968 26 p refs Transl. into ENGLISH from the Publ. "Trudy 17-Y Astrometricheskoy Konferentsii SSSR" Leningrad, Nauka Press, 1967 p 89-98, 119-122
(JPRS-46195) CFSTI: HC$3.00/MF$0.65

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1. METHODS OF ACCOUNTING FOR VARIATIONS OF INSTRUMENT SYSTEMATIC ERRORS FROM NIGHT TO NIGHT L. M. Khommik p 1-16 refs (See N68-34236 21-14)

2. ANALYSIS OF THE ACCURACY AND SYSTEMATIC ERROR OF THE SHTERNBERG OBSERVATORY MERIDIAN CIRCLE V. V. Podobed p 17-21 (See N68-34237 21-14)

N68-34236# Joint Publications Research Service, Washington, D. C.
METHODS OF ACCOUNTING FOR VARIATIONS OF INSTRUMENT SYSTEMATIC ERRORS FROM NIGHT TO NIGHT
L. M. Khommik *In its* Systematic Errors of Astrometric Instr. 14 Aug. 1968 p 1-16 refs (See N68-34235 21-14)

Methods to determine variations in instrument errors are discussed in relation to the accurate determination of star positions. Flexure is considered the primary source of systematic errors, and observational data are reduced with this in mind. Various studies relating to data reduction are reported. M.W.R.

N68-34237# Joint Publications Research Service, Washington, D. C.
ANALYSIS OF THE ACCURACY AND SYSTEMATIC ERROR OF THE SHTERNBERG OBSERVATORY MERIDIAN CIRCLE
V. V. Podobed *In its* Systematic Errors of Astrometric Instr. 14 Aug. 1968 p 17-21 (See N68-34235 21-14)

A new meridian circle constructed for the Moscow observatory has an objective diameter of 180 mm, focal length of 2400 mm, and centerline distance between trunnion sections of 1250 mm. The circle is equipped with auxiliary devices to determine systematic errors and instrument stability. Preliminary data are reported for initial observations with the instrument, along with some reduced data to indicate overall instrument accuracy. M.W.R.

N68-34269# Teldix Luftfahrt-Ausruestungs G.m.b.H., Heidelberg (West Germany).
SOME ASPECTS RELATED TO DESIGN AND TECHNOLOGY OF THE HYDRODYNAMIC GAS BEARING GYRO GKM 38 [KONSTRUKTIVE UND TECHNOLOGISCHE ASPEKTE BEI DER ENTWICKLUNG EINES KREISELMOTORS MIT HYDRODYNAMISCHER GASLAGERUNG (GKM 38)]
W. Fehse May 1968 37 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMwF-FB-W-68-31) CFSTI: HC$3.00/MF$0.65

The present report is intended to give an insight into the technological and constructural problems arising during the development of a gas bearing gyro motor by the example of the development of the GKM 38 at TELDIX. After a brief survey of the state of art and literature at home and abroad at the beginning of the development work, the first sections specify the requirements of inertial grade gyro motors, discussing within the scope at the same time the advantages and disadvantages of both the possible bearing geometric and drive motor configurations. The succeeding sections contain in addition to detailed design descriptions a thorough discussion of the problems, which arose at the various development stages of the GKM 38, and their respective solution. The last section finally indicates the necessary additional treatments of the complete gas bearing gyro motor prior to the installation into the float of the gyro unit. Author (ESRO)

N68-34281*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
USE OF A MAGNETIC AZIMUTH-INDICATOR SYSTEM DEVELOPED FOR BALLOON PAYLOADS OF THE PLANETARY ENTRY PARACHUTE SYSTEM
Wayne L. Darnell [1968] 19 p Presented at the 5th AFCRL Sci. Balloon Symp., Portsmouth, N. H., 17-19 Jun. 1968
(NASA-TM-X-61211) CFSTI: HC$3.00/MF$0.65 CSCL 09F

An azimuth-sensing system was used for continuous, ground monitoring of the azimuth orientation of the balloon-borne Planetary

Entry Parachute Program (PEPP) spacecraft. The system utilized two magnetic field sensors located in the spacecraft so as to produce a unique set of voltage outputs for any azimuth. Electronics onboard the spacecraft encoded the magnetometer outputs and fed the encoded signal to a C-band modulator which imposed the intelligence onto the radar tracking beacon pulses. A conveniently located ground radar received the modulated pulses and the magnetometer outputs were reproduced after demodulation. For fast, direct readout, an X-Y plotter was calibrated to cross plot the reproduced signal of the two magnetometers on a combination rectangular-polar graph indicating the correct true azimuth in real time. The method was used successfully on three of the PEPP balloon-borne spacecraft to determine when the spacecraft was pointed in the most advantageous direction for release from the balloon, at 130,000 feet altitude. The use of such a system of azimuth monitoring is suitable to balloon payloads which are virtually stable with respect to the horizontal but may be rotating about the vertical axis. Angular accuracies within $\pm 10^{\circ}$ could generally be expected. Author

N68-34306# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
SENSITIVE ALPHA-RAY AND BETA-RAY COLORIMETER
D. M. Fleming Jan. 1968 11 p *ref*
(Contract AT(45-1)-1830)
(BNWL-590) CFSTI: HC $3.00/MF $0.65

A sensitive calorimeter suitable for measuring the power output of small alpha and beta ray sources is described. The calorimeter is of the twin type and is capable of detecting power levels as low as 5×10^{-7} watts. Author (NSA)

N68-34311# Environmental Science Services Administration, Atlantic City, N. J. Observations and Method Branch.
DEVELOPMENT OF TRANSMISSOMETER CALIBRATION TECHNIQUES AND DEVICES, PHASE 1 Interim Report
Frederick C. Hochreiter Feb. 1968 61 p refs Prepared for FAA
(RD-68-7)

Two side-by-side 250-ft. baseline transmissometers are used to isolate calibration techniques that may be useful under all visibility conditions. Current calibration procedures are limited to application in visibilities of 5 miles or more. A review of these procedures is presented. Testing anticipates extending some calibration techniques to visibilities less that 5 miles. Preventive maintenance procedures are discussed which may be utilized to minimize transmissometer outages. Interim results of testing show that the practice of aging CE-75 phototubes should not be overlooked. The Appendix presents detailed transmissometer alignment and calibration procedures reflecting current techniques. Author

N68-34325*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MICROELECTRIC DATA AND CONTROL TRANSMISSION SYSTEM FOR DYNAMIC WIND-TUNNEL TESTING
James H. Schrader and C. D. Nichols Jun. 1968 26 p Presented at the 14th Natl. Aerospace Symp., Boston, 3–5 Jun. 1968
(NASA-TM-X-61231) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Details are given on a microelectronic data and control transmission system designed for use in a wind tunnel where access to the test model is not practical during a relatively long period of time covering a series of test conditions. It provides for remote control of various electromechanical transducers in the model and the complete remote setup capability on the data system. The overall system is capable of transmitting up to 20 high-response data signals from the model and up to 54 auxiliary control functions to the model over a single 1/16-inch-diameter cable. Author

N68-34353*# Scripta Technica, Inc., Washington, D. C.
PROJECT SERE: AN OUTLINE OF THE NATURAL RESOURCES REMOTE SENSING RESEARCH PROGRAM
J. B. Machado NASA Sep. 1968 29 p Transl. into ENGLISH of the book "Esboco de Programma de Pesquisas em Sensoriamento Remoto de Recurso Naturais" Sao Paulo, Sao Jose dos Campos, Jun. 1968 47 p
(Contract NASw-1694)
(NASA-TT-F-11887) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report introduces the concept of remote sensing; describes briefly the present state of the art in the U.S.A., gives preliminary equipment lists, suggests a distribution of personnel available and establishes criteria for test site selection, suggesting some locations in Brazil. Author

N68-34358# European Atomic Energy Community, Ispra (Italy).
IMPROVEMENT IN THE PERFORMANCE OF A BF SUB 3 COUNTER BANK BY MEANS OF A TRANSISTORIZED MIXER CIRCUIT FOR USE IN NEUTRON TIME-OF-FLIGHT MEASUREMENTS [AMELIORATION DES PERFORMANCES D'UN BANC DE COMPTEURS A BF SUB 3 AU MOYEN D'UN CIRCUIT MELANGEUR TRANSISTORISE, POUR UTILISATION DANS DES MESURES PAR TEMPS DE VOL DE NEUTRONS]
G. Fraysse, G. Riccobono, and P. Detourbet Brussels Jun. 1968 17 p refs In FRENCH; ENGLISH summary
(EUR-3942.f) CFSTI: HC $3.00/MF $0.65

Parallel coupling of BF_3 counters in a bank for time-of-flight measurements presents the two following main inconveniences: (1) the internal capacitances of the counters being added, the pulses get an important attenuation of the signal-to-noise ratio, and (2) due to unavoidable differences between several counters, the poor amplitude resolution of such an arrangement makes necessary the use of a too high discriminstion threshold reducing the detection efficiency. The performances of a single counter can be preserved if each counter is connected with a twin emitter follower for impedance matching. Then, the pulses are mixed in a transistorized circuit with a low impedance output for the connection with the main amplifier at a large distance. Furthermore, an adjustment of the gain of each way allows the compensation of the differences between the multiplication coefficients of every counter. With such a system, there is the advantage, in the case the γ background is high, to have the possibility to utilize independently in each way a discrimination threshold limiting the final pile-up. The performances of this arrangement are presented and compared to those of a single counter. Author

N68-34362# Federal Aviation Agency, Atlantic City, N. J. National Aviation Facilities Experimental Center.
EVALUATION OF A PICTORIAL TURN AND BANK INDICATOR Final Report
Gerald E. Skelton Aug. 1968 14 p
(NA-68-28; DS-68-14)

A subjective evaluation was conducted of a pictorial turn indicator as a replacement for the conventional turn and bank indicator. Results showed that a pictorial turn indicator can replace the turn and bank indicator without any adverse effect, and that the novice VFR pilot or a current IFR pilot can use a pictorial turn indicator alone without confusing it with any other flight instrument. Operationally, all pilot subjects were able to fly the required IFR basic air maneuvers proficiently in both smooth and turbulent air. There were no unusual responses to the unusual maneuvers when the outside-in presentation of a pictorial turn indicator was mixed with the inside-out presentation of the conventional attitude indicator. The low-time VFR pilot, flying solely by instruments, demonstrated an ability to perform timed turns with confidence and greater accuracy than when using the conventional turn needle. Author

N68-34371# Los Alamos Scientific Lab., N .Mex.
REAL-TIME SAMPLING BEAM POSITION MONITOR
J. M. Potter [1968] 18 p Presented at Conf. on Proton Linear Accelerators, Upton, N. Y. Supported in part by AEC
(LA-DC-9431; CONF-680515-15) CFSTI: HC$3.00/MF$0.65

A beam position monitor using the RF structure of the beam is described for use with the LAMPF linac. Theory of operation, sensitivity of beam coupling loop, circuit design, monitor loops, gated mixers, logarithmic IF amplifier, de-multiplexer, time base generator, and operational tests are discussed. NSA

N68-34442*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FM/AM TELEMETRY TO MEASURE IMPACT ACCELERATIONS
Dean R. Harrison [1968] 11 p refs Presented at the 14th Natl. ISA Aerospace Instrumentation Symp., Boston, 3–5 Jun. 1968
(NASA-TM-X-61204) CFSTI: HC$3.00/MF$0.65 CSCL 09F

An FM/AM telemetry system has been designed which provides three-axis acceleration measurements during impact tests of models of soft-landing structures. The system was designed to employ a three-axis piezoelectric accelerometer working into three separate FM/AM telemeter circuits. Each carrier was received and detected by a separate receiver at the ground station. The subcarrier output of the receiver was recorded directly on magnetic tape. The frequency of the subcarrier was preset to the center frequency of the tape recorder FM-reproduce electronics to facilitate demodulation of the recorded subcarrier during playback of the tape. During calibration drop tests acceleration wave forms were recorded by both telemetry and direct wire techniques. Wave-form comparisons showed close correlation for each axis tested. Author

N68-34480# Argonne National Lab., Ill.
POSITION SENSITIVE COUNTERS
W. R. Kuhlmann, K. H. Lanterjung, B. Schimmer, and K. Sistemich May 1968 6 p refs Transl. into ENGLISH from Nucl. Instr. Methods (Neth.), v. 40, 1966 p 118–120
(ANL-TRANS-621) CFSTI: HC$3.00/MF$0.65

Charged particles produce in proportional counters with the cathode or the anode of material with suitable resistance an energy-independent information of the position which is a linear function of the location. The resolution of the counter to be described (length 30 cm) amounts to 1.2 mm. Author (NSA)

N68-34487*# Rensselaer Polytechnic Inst. of Connecticut, Inc., East Winsor Hill, Hartford Graduate Center.
QUADRUPOLE IONIZATION GAUGE
Helmut Schwarz Apr. 1968 14 p refs Presented at the 4th Intern. Vacuum Congr., Manchester, Engl., 17–20 Apr. 1968
(Grant NGR-07-009-001)
(NASA-CR-96818) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The difference between the Penning gauge and the new ionization gauge lies mainly in the fact that the confinement of the electrons is achieved by electrostatic quadrupole lenses instead of a magnetic field. Electrons are emitted from a hot cathode at one end of the tube and accelerated along the tube. They will then encounter an inverted field which will cause the electrons to return and continue to oscillate obtaining maximum velocity each time they pass the middle of the tube. The produced ions are collected by a cylindrical screen surrounding the whole electrode structure and/or the flat disc. The tube can be operated in two modes: 1) d. c. potentials or 2) ultra high frequency are applied to the quadrupole rods. In the case of the d.c. operation, the sensitivity factor was by a factor of 10 and in the high frequency operation by a factor of more than 2,000 higher than that of a regular Bayard-Alpert gauge. The X-ray limit is so low that it plays a lesser role than adsorption and desorption phenomena at the ion collector. Adsorption and desorption processes come to an equilibrium in front of the ion collector and create a kind of "gas cloud". Author

N68-34489*# Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy.
IMAGE INTENSIFIER PHOTOGRAPHY OF SIMULATED SHOWERS IN LARGE AREA LAYERS OF PLASTIC SCINTILLATORS
R. W. Huggett, T. Sapdor, and J. E. Webb [1967] 14 p refs Presented at the 10th Intern. Conf. on Cosmic Rays, Calgary, Alberta, Jun. 1967 Submitted for publication *Its* Paper Tech-21
(Grant NGR-19-001-012)
(NASA-CR-87752) CFSTI: HC$3.00/MF$0.65 CSCL 14E

Preliminary results are presented of some tests which were made to determine the feasibility of using an image intensifier camera to photograph showers developing within an ionization calorimeter containing large sheets of plastic scintillator. In the tests the camera is used to view the shorter edge of a sheet of Pilot Y plastic scintillator 91.5 cm × 183 cm and 2.5 cm thick. Showers of various sizes occurring within the scintillator are simulated by a nanosecond light source of appropriate size which is inserted into holes in the scintillator. The tests show that with the optical system anticipated to be used in the final application the threshold for shower detection seems to be sufficiently low and the image size sufficiently small to enable the system to be used over the required depth of field to obtain space and energy resolution of showers that occur simultaneously within the calorimeter with energies around 10 TeV. Author

N68-34507# Brookhaven National Lab., Upton, N. Y.
SOME NEW DETECTOR SYSTEMS
S. J. Lindenbaum 29 May 1968 23 p refs Presented at the Conf. on Exptl. Meson Spectry., Philadelphia, 26–27 Apr. 1968 Sponsored by AEC
(BNL-12539; CONF-680428-4) CFSTI: HC$3.00/MF$0.65

Two hodoscope detector systems used for single particle detection and momentum measurement by a magnetic spectrometer system with on line computer determination of missing mass are described. The first system is a counter hodoscope system whereas the second is a spark chamber hodoscope wire system. A new double vertex magnetic spectrometer detector system which is scheduled for assembly and testing in the fall of 1968 is also described. This system will be composed of two multiparticle detecting magnetic spectrometer arms on-line to a computer and will be suitable for detecting and automatically measuring the momentum of the charged decay particles from double vertex events. NSA

N68-34523# California Univ., San Diego. Visibility Lab.
AN EXAMPLE OF AN EARLY TECHNIQUE FOR VISIBILITY CALCULATIONS
Jacqueline I. Gordon and Peggy V. Church Jun. 1968 43 p refs Submitted for publication
(Contract NObs-84075)
(SIO-REF.-68-13; Rept.-5; AD-672355)

This report describes results from previously unreported visibility calculations made in the spring of 1957, of aerial observer sighting and recognition ranges for a complex object. The object is a toy model scaled to vehicle size, lighted by sun and sky, and screened by the real atmosphere. Most of the ranges are presented graphically as a function of altitude for one search method; viz, visual fixation at the optimal angle of sight, area coverage being provided by the forward movement of the plane. Sample results are also given for other methods of search. Author (TAB)

N68-34545# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
INSTRUMENTED PROBES FOR DEEP GLACIAL INVESTIGATIONS
Haldor W. C. Aamot May 1968 14 p refs
(CRREL-TR-210; AD-672057)

Thermal probes have been developed that can carry instrumentation packages into polar ice sheets for geophysical investigations and long-term observations by remote measurement. They are self-contained, surface-controlled devices. During development work at USA CRREL problems with materials, fabrication, and heat transfer analysis were solved. The Philberth probe, named after its inventor, demonstrated its performance capability in Greenland. The pendulum probe was a further development with increased performance and versatility. Author (TAB)

N68-34618# Army Engineer Topographic Labs., Fort Belvoir, Va.
TRANSFORMING PRINTERS: ACCEPTANCE AND ENGINEERING TESTS Technical Report, May–Sep. 1967
George S. Barber and J. Wiley Halbrook May 1968 44 p
(USAETL-TR-40; AD-672062)

This report covers acceptance and engineering tests of two transforming printers: one for rectification of tilts of 24 1/2 degrees and the other for rectification of tilts of 49 degrees. The tests consisted of observation and testing to determine conformance to the purchase description and engineering tests to determine limits of accommodation and performance. Author (TAB)

N68-34634# Los Alamos Scientific Lab., N. Mex.
A PNEUMATIC SYSTEM FOR TRANSFERRING SAMPLES AUTOMATICALLY BETWEEN IRRADIATION AND DETECTION POSITIONS
B. M. Moore, H. M. Ruess, and J. E. Swansen 4 Jun. 1968 7 p
(Contract W-7405-eng-36)
(LA-3862) CFSTI: HC $3.00/MF $0.65

A pneumatic system for transferring samples from a storage chamber to irradiation and detection stations and back to the storage chamber has been constructed. The mechanical, pneumatic, and electronic systems used are described. With this device, many samples can be irradiated and counted with little work on the part of the experimenter. Author (NSA)

N68-34655# Laboratoire Suisse de Recherches Horlogères, Neuchatel (Switzerland).
MEASUREMENT OF THE INFLUENCE OF GRAVITY ON THE OPERATION OF AN ATOMIC CLOCK [MESURE DE L'INFLUENCE GRAVITATIONNELLE SUR LA MARCHE D'UNE HORLOGE ATOMIQUE]
P. Kartaschoff, C. Menoud, J. Racine, G. Epprecht (Eidgenossische Tech. Hochschule), C. Mahle (Eidgenossische Tech. Hochschule) et al Jun. 1966 21 p In FRENCH *Its* Res. Proj. No. 0809 Prepared jointly with Eidgenossische Tech. Hochschule
CFSTI: HC $3.00/MF $0.65

A Swiss participation in the NASA Red Shift Experiment is envisaged. An advance project of the Swiss contribution is drawn up. Global cost estimates are given such as characteristics of receivers and masers for frequency comparison. ESRO

N68-34661# Stanford Univ. Calif. Dept. of Geophysics.
THE EVALUATION OF MULTISPECTRAL IMAGERY FOR A TIDAL MARSH ENVIRONMENT
Raymond Pestrong 1968 55 p refs
(Contract NONR-4430(00))
(AD-672188)

A variety of multispectral imagery, including nine-lens multiband imagery in the 400-900 millimicron range, panchromatic, Ektachrome, and Ektachrome-Infrared photography, has been obtained for a tidelands area in San Francisco Bay. A technique for comparing their relative utility for specific geomorphic interpretations has been developed, whereby a subjective form of tracing analysis may be correlated with a more objective (and quantitative) scheme of selected microdensitometer traverses across the various negatives and positive transparencies. The results suggest that the nine-lens multiband imagery is excessive, and, that for a similar use as that of the photos studied, could be reduced to four-lens imagery. The most useful frames are the 550-630 millimicron bandwidth, the near-infrared, the Ektachrome color transparency, and the Ektachrome-Infrared transparency. Author (TAB)

N68-34671*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INTERACTION EFFECTS IN MEASUREMENTS SYSTEMS
D. R. Englund [1968] 27 p Presented at the 15th Ann. Electron. Conf., Cleveland, 16–18 Apr. 1968
(NASA-TM-X-61244) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Presented is a discussion of the problem of matching an instrument to a system such that a minimum disturbance is generated when the instrument is connected. The concept of loading, as determined by such properties as impedance or stiffness, is used to describe these interaction effects. Practical examples of measurements of electrical quantities, temperature, force, pressure, and flowrate are used as a basis for the discussion. Author

N68-34672*# Stanford Univ., Calif. Genetics Dept.
COMPUTER CONTROL OF MASS ANALYZERS
W. E. Reynolds, J. C. Bridges, R. B. Tucker, and T. B. Coburn [1968] 17 p Presented at the ASTM 16th Ann. Conf. on Mass Spectrometry and Allied Topics, Pittsburgh, 12 May 1968
(Grant NsG-81; Contract AF 49(638)-1599)
(NASA-CR-96821) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Extending the use of digital computers from passive data collection to active control has increased the efficiency of computer-mass spectrometer systems. One such system devised, and described in this report, used a small digital computer and integer resolution (quadrupple and time of flight) mass spectrometers. The computer, by teletype, queries the user for operating parameters. The computer then translates these into detailed control functions that operate the instrument. Calibration is effected by the computer valving into the mass spectrometer a reference gas prior to introduction of the unknown sample. After calibration, the sample data acquired by the mass spectrometer is made available to the researcher in an on line graphic system. Author

N68-34712# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
MULTICHANNEL EDDY CURRENT TUBING TESTER
H. L. Libby and C. R. Wandling 28 May 1968 30 p refs
(Contract AT(45-1)-1830)
(BNWL-765) CFSTI: HC $3.00/MF $0.65

A two channel, two frequency, eddy current, tubing nondestructive test device is described in which the undesirable effect of test probe wobble signals is reduced on both channels. A novel analyzer circuit or signal transformation section is used for the successive elimination of parameters. The tester is flexible in operation and can be operated using either of its two test frequencies, 100 and 300 kHz singly, or both simultaneously. When operated in its single frequency modes, two test parameters, for example probe wobble, and the presence of defects giving signals having components in quadrature with probe wobble signals may be separated. When operated in its two frequency mode the effects of one test parameter can be minimized and the effects of two other test parameters may be read out. Instrument test results for the two frequency mode of operation are shown in which probe wobble signals are minimized on both of the two output channels

and signals due to defects opening on the inner wall of the tubular test specimen appear on one channel, and signals due to defects opening on the outer wall of the specimen appear on the other channel. Author (NSA)

N68-34731# Argonne National Lab., Ill.
PULSE DIVISION CIRCUIT
W. R. Kuhlmann and B. Schimmer May 1968 11 p refs Transl. into ENGLISH from Nucl. Instr. Methods (Neth.), v. 40, 1966 p 113–117
(ANL-TRANS-622) CFSTI: HC $3.00/MF $0.65

For experiments with detectors for localization of particles a pulse division circuit was evaluated that derivated an output pulse from two coincident input signals U_1, U_2, the amplitude of which was proportional to the quotient $Q = U_1/U_2$ of the two input signals. The circuit works in a range $1 \leq Q < 5$. For $Q = 1$ the input signals may vary in a range $8\ V < U_{1,2} < 100\ V$, for $Q = 3$ in $30\ V < U_1 < 100\ V$ and $10\ V < U_2 < 33\ V$. The greatest repetition rate with periodical pulses is about 5 kc/s for $Q = 3$ and $U_2 = 20$ V, if one wants to keep the deviations from the value at low frequencies below 10%. The output signals are so shaped, that they may be analyzed directly by the usual multi-channel-pulseheight-analyzators ($t_r < 0.5$ μsec; $t_f < 3$ μsec). The input signals have to accomplish only one condition: their risetime t_r must be less than 0.5 μsec. Author (NSA)

N68-34734*# Electro-Optical Systems, Inc., Pasadena, Calif.
RESEARCH AND DEVELOPMENT OF A NEW TECHNIQUE FOR SENSING PRESSURE Final Report, 17 Mar.–16 Dec. 1967
G. Kuskevics 6 Feb. 1968 159 p refs
(Contract NAS8-21068)
(NASA-CR-96717; EOS-7204-Final) CFSTI: HC $3.00/MF $0.65 CSCL 14B

New concepts in electro-optical and stress-sensitive junction and integrated circuit techniques were examined for feasibility of application of digital and/or analog pressure transducers. Several promising new designs were tested in breadboard configurations for performance and limitations. The work covered design and testing of a solid state autocollimator pressure transducer utilizing a semiconductor laser, interferometric displacement sensors, a split grating interferometer strain gage, moire fringes, and the use of stressed lasers. An extensive literature search was conducted on stressed junction application to pressure sensing. Results of work on tension or compression by bending on a beam or diaphragm are presented, including data on p–n junction-isolated silicon strain gages, temperature-compensated Zener diodes, tunnel diodes, unijunction transistors, and n–p–n transistors. Other studies dealt with the application of stressed junction sensors to low pressure transducers. K.W.

N68-34756# European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.
AUTOMATIC FLUX DISTRIBUTION RECORDING DEVICE FOR USE IN SUBCRITICAL ASSEMBLIES OR REACTORS [DISPOSITIF D'ENREGISTREMENT AUTOMATIQUE DE DISTRIBUTIONS DE FLUX DANS DES REACTEURS OU ENSEMBLES SOUS-CRITIQUES]
G. Fraysse, W. Hage, and I. Palah Brussels 1968 14 p refs In ITALIAN; ENGLISH summary
(EUR-3943.f)

The measurement of neutron flux distributions in a system requires the utilization of a convenient detector: activation detectors, fission detectors, or detectors based on a neutron reaction. The difficulties arising from the simultaneous counting in a multiway device of each detector were most eliminated by a multiscalar analyzer. Furthermore, simple address programming allows Fourier analysis of the spectra. The use of a multidimensional analyzer allows also the space representation of the neutron population, total or decomposed in its fundamental and harmonics for processing in a computer. Author

N68-34789# Chicago Univ., Ill.
AN AIRBORNE CONTINUOUS CLOUD PARTICLE REPLICATOR
Paul A. Spyers-Duran and Roscoe R. Braham, Jr. *In its* Cloud Phys. Lab. 15 Aug. 1968 7 p refs Repr. from J. Appl. Meteorol., v. 6, no. 6, Dec. 1967 p 1108–1113 refs (See N68-34783 21-20)
(Grants NSF G-8214; NSF GP-3779)

An instrument for collecting cloud particles from an airplane has been developed. Cloud particles are captured and permanently replicated using the well known Formvar technique. From the continuous record of hydrometeor replicas, the forms, sizes and frequency distributions can be established. Description of the instrument and examples of data collected from natural clouds are presented. Problems of calibration are discussed. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N68-33687*# General Precision, Inc., Little Falls, N. J. Aerospace Group.
ALUMINA BEARING IN GAS-LUBRICATED GYROS
John L. Rutherford and William B. Swain [1967] 9 p Presented at the AIAA/ASME 8th Structures, Structural Dyn., and Mater. Conf., Palm Springs, Calif., 29–31 Mar. 1967
(Contract NAS12-90)
(NASA-CR-88597) CFSTI: HC $3.00/MF $0.65 CSCL 13I

The friction and wear properties of various forms of alumina for use in gas-bearing gyros were determined. Studied were 100% dense Al_2O_3, cemented Al_2O_3, hot-pressed Al_2O_3, and plasma-arc deposited Al_2O_3 on beryllium. Flat, thrust-washer type specimens were used, with each material tested against itself only. Experimental variables included sliding velocity, normal force, temperature, running time, and environment. Bearing surfaces were fully characterized using roughness measurements, Talysurf profilometry, interferometry, optical and electron microscopy, and X ray analysis. In general, the coefficient of friction was: (1) independent of normal force; (2) decreased at high sliding velocities (hydrodynamic lift-off); (3) not affected by relative humidity (below 90%) or temperature; (4) increased with the onset of damage. Improved resurfacing techniques were developed that provided surfaces having lower coefficients of friction and greater resistance to damage from sliding contact. Each material was tested in compression and the microcreep properties were measured at a strain sensitivity of 10^{-6} Author

N68-33695 Case Inst. of Tech., Cleveland, Ohio.
STUDIES ON THE NOISE CHARACTERISTICS OF TAPERED ROLLER BEARINGS
Richard Frank Lucht (Ph.D. Thesis) 1967 171 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-16086

In an effort to gain detailed insight into several phenomena associated with bearing noise, a study was performed in which it was established that 1/3 octave acceleration levels, with center frequencies in excess of approximately 200 cps, are valid indicators

of the noise as perceived by an average listener. The lack of validity below 200 cps is explained by the presence of discrete frequency noise, which is dependent upon gross bearing geometry and motion, and by strain effects on the accelerometer. This method of testing was found to be sufficiently sensitive to distinguish among individual rollers and cones. In making use of this fact, it was concluded that the overall noise of a bearing is primarily influenced by the surface geometry of the rollers. These shortcomings plus two additional reasons (inherent lack of repeatability and θ-dependence of the signal) prompted the investigation of a method for measuring the axial acceleration of the bearing. Employing this method, it was established that the amplitude of the acceleration spectrum is functionally related to the speed of the bearing.
Dissert. Abstr.

N68-33820# National Engineering Lab., Glasgow (Scotland).
THE APPLICATION OF HYDROSTATIC PRESSURE TO METAL WORKING. PART 1: EXTRUSION
H. L. D. Pugh Dec. 1967 19 p refs
(NEL-334) CFSTI: HC $3.00/MF $0.65

This paper is the first of a set of three concerned with the derivation of the general principles governing the application of hydrostatic pressure to metal working. The present paper briefly indicates how, in hydrostatic extrusion, the pressurized fluid provides an infinitely flexible frictionless container, can apply deforming stresses to any complicated and changing shape of billet, provides good lubrication and lateral support to tooling and billets so that extremely long non-straight billets can be used, and gives a process analogous to drawing, from which the limitation imposed by tensile stresses has been eliminated. The application of a back pressure to a product cold extruded by the conventional or by the hydrostatic process makes it possible to inhibit cracking normally obtained in work materials of limited ductility and to obtain products of improved properties (namely, ductility) in other work materials.
Author

N68-33821# National Engineering Lab., Glasgow (Scotland).
THE APPLICATION OF HYDROSTATIC PRESSURE TO METAL WORKING. PART 2: DRAWING
H. L. D. Pugh Dec. 1967 17 p refs
(NEL-335) CFSTI: HC $3.00/MF $0.65

This paper on drawing is the second of a set of three concerned with the derivation of the general principles governing the application of hydrostatic pressure to metal working. The present paper firstly establishes that hydrostatic pressure does not affect the instability point in tension. The corollary is that the application of hydrostatic pressure to such processes as drawing does not enable larger changes of shape (e.g. larger reductions in area) to be obtained without a radical modification of the process. However, products (wire and sheet) drawn under normal process conditions suffer less internal damage, and consequently have better properties, when drawn in the presence of a hydrostatic pressure. The application of a hydrostatic pressure to a blank can largely transform conventional deep drawing into a lateral extrusion operation with a resulting increase in the draw ratio due to the removal of the tensile stresses.
Author

N68-33823# National Engineering Lab., Glasgow (Scotland).
THE APPLICATION OF HYDROSTATIC PRESSURE TO METAL WORKING. PART 3: FORGING AND OTHER PROCESSES
H. L. D. Pugh Dec. 1967 19 p refs
(NEL-336) CFSTI: HC $3.00/MF $0.65

This paper, dealing with forging and other processes, is the last of a set of three concerned with the derivation of the general principles governing metal working. In the forging and upsetting of rods and tubes, back pressure applied in a variety of ways, namely by a liquid, a solid, or by mechanical means, inhibits cracking in brittle materials and enables much larger deformation to be obtained, and with other materials, gives products (after a given deformation) of better properties. In tube expansion, external hydrostatic pressure providing a back pressure and lateral support enables much larger expansions to be obtained, the necking tendency being reduced by the simultaneous axial compression of the tube supported and lubricated by the high-pressure film between the tube and die. The degree of bending without cracking of brittle materials is considerably increased in carried out in the presence of a hydrostatic pressure. In other metal working applications, the high-pressure medium can be used to replace part of the tooling. The paper ends with a summary of the general principles governing the application of hydrostatic pressure to metal working.
Author

N68-33849*# Hi-Shear Rivet Tool Co., Torrance, Calif. Ordnance Div.
EBW PRESSURE CARTRIDGE Summary Report
25 Jul. 1968 44 p
(Contract NAS8-20724)
(NASA-CR-96551) CFSTI: HC $3.00/MF $0.65 CSCL 19A

Technical data was investigated to determine the most promising materials and design for the pressure cartridge. The prototype design was established, and tests performed to substantiate the design. The fabrication of the cartridges is discussed. The devices manufactured will be used to perform a development test to assure the pressure cartridge meets the design specifications.
Author

N68-33851# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TECHNOLOGY OF MACHINERY MANUFACTURE (SELECTED ARTICLES)
29 Jun. 1967 27 p refs Transl. into ENGLISH from the Publ. "Tekhnologia Mashinostroyeniya" Kiev, Izd. Tekhn., v. 1, 1966 p 91-105
(FTD-HT-67-127; AD-671655)

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1. INVESTIGATION OF VIBRATION COMPACTION OF POWDERS OF HARD ALLOYS I. P. Tartakovskiy and V. V. Ivashchenko p 1-9 refs (See N68-33852 21-15)

2. EXPLOSIVE METALWORKING O. N. Chkalova p 10-20 refs (See N68-33853 21-15)

N68-33852# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF VIBRATION COMPACTION OF POWDERS OF HARD ALLOYS
I. P. Tartakovskiy and V. V. Ivashchenko *In its* Technol. of Machinery Manuf. 29 Jun. 1967 p 1-9 refs (See N68-33851 21-15)

The results of investigating means of vibrational consolidation of powders of hard alloys VK-6 and VK-20 are presented. The test equipment allows the independent determination of the necessary parameters of vibration: amplitude, vibration frequency, and amount of static load. A schematic diagram of the test device is shown. Test measurements are plotted to portray the variation of powder briquet density as a function of vibrational frequency and amplitude, and as a function of static pressure. The studies showed that for alloys VK-6 and VK-20 higher densities are obtained with greater vibrational amplitudes. In the experimental conditions for this series of tests frequency was not found to have an appreciable effect on the consolidation process. There is an upper limit of amplitude; above this limit value the briquets may be destroyed. Vibrational consolidation increases with higher static pressures, however, the intensity of densification decreases with increasing

static pressure. The results show that it may be feasible to use electromagnetic vibrators for industrial production of the alloys tested. Author

N68-33853# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPLOSIVE METALWORKING
O. N. Chkalova *In its* Technol. of Machinery Manuf. 29 Jun. 1967 p 10–20 refs (See N68-33851 21-15)

Consideration is given to the advantages of explosives in the production of large metal objects which require shaping. Methods employing high-speed and low-speed are described and evaluated in terms of specific utilization. The three principal methods now in use are listed as: (1) shaping directly by the explosive gas, (2) shaping by hammers operated by pressure of gases produced during an explosion, and (3) shaping by transmission of pressure through a liquid. A general discussion of typical applications of each of the methods is included. Author

N68-34100# Hawker Siddeley Aviation, Ltd., London (England).
PRE-PRESSURE JIG WELDING OF A LARGE STAINLESS STEEL AIRCRAFT FUEL TANK
London Min. of Technol. Mar. 1968 34 p
(Contract KS/1/0417/C.B.43(a)2)
(S&T-MEMO-9/67) CFSTI: HC $3.00/MF $0.65

Describes the pre-pressure resistance spotwelding technique which was developed to spotweld internal formers to the skin of a saddle shaped fuel tank. A detailed description of the design of the welding fixture incorporating the secondary resistance welding circuit is given and also results of welding tests carried out. Possible future development of the pre-pressure welding technique is discussed. Author (ESRO)

N68-34248*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
METALLURGICAL ASPECTS OF RELIABILITY FOR SMALL NITRIDED PARTS
Alfred J. Babecki [1967] 25 p Presented at the SAE/AIAA/ASME Reliability and Maintainability Conf., Cocoa Beach, Fla., 17–19 Jul. 1967 Submitted for publication
(NASA-TM-X-59847) CFSTI: HC $3.00/MF $0.65 CSCL 14D

Many spacecraft experiments and systems employ drive systems which contain gear trains, slides, rachets, and similar components subject to sliding wear. In order to inhibit or mitigate the wear, some manufacturers employ surface hardening processes, including nitriding. Cases of three such applications are reviewed. One involved rachets made of Nitralloy 135M on a spectrometer grating drive. These rachets suffered excessive embrittlement of the very small (10 mil height) rachet teeth. Another case involved Type 416 stainless steel gears in a small motor gear train. These were nitrided by a proprietary process and suffered flaking of the nitriding and chipping of the gear teeth during testing. A third case involved a pinion gear on an infrared scanner which also was made of Nitralloy 135M and nitrided to increase its surface hardness. Author

N68-34256 Laboratorio de Acustica e Sonica, Sao Paulo, (Brazil).
ULTRASONIC INSPECTION OF WING SPAR ATTACHMENT JOINTS IN VISCOUNT AIRCRAFTERS
[1968] 14 p
(TR-6806.328)

Data are presented on the results of using ultrasonic inspection techniques for the detection of fatigue cracks in the wing spar attachment joints of Viscount aircraft. The procedures and test equipment are also described. B.S.D.

N68-34263*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR PNEUMATIC CYLINDER MILLER FLUID PART NUMBER C14618, NASA DRAWING NUMBER 75M06909-1, REVISION B
20 Aug. 1968 59 p
(Contract NAS8-4016)
(NASA-CR-98543; TR-RE-CCSD-FO-1141-3, Rev. B) CFSTI: $3.00 CSCL 13G

This report describes the results of tests performed to determine if pneumatic cylinder 75M06909-1 meets the operational and environmental requirements for John F. Kennedy Space Center launch complexes 34 and 37. A summary of the test results is presented. Three pneumatic cylinders were numbered specimens 1 through 3 for identification. A table lists the tests performed, the specimen used for each test, and the test media, when applicable. Author

N68-34271* Aerojet-General Corp., Sacramento, Calif. Liquid Rocket Operations.
DEVELOPMENT OF STEADY-STATE AND DYNAMIC PERFORMANCE PREDICTION METHODS FOR TURBOPUMP SELF-COMPENSATING THRUST BALANCE SYSTEMS
W. E. Watters, L. Luehr, P. S. Buckman, and M. J. Gerber 19 Sep. 1968 417 p refs
(Contract NAS3-7978)
(NASA-CR-72430; AGC-9400-9) CFSTI: $3.00 CSCL 13K

Three tasks are described: the hydrodynamic design and mechanical layout of the test assembly, the formulation of analytical models to predict performance, and parametric studies. The tester was designed to accommodate either a series flow (single acting) or a parallel flow (double acting) balance piston with provisions to permit the varying of sill lengths, pocket depths, orifices, mechanical spring rate, and friction damping. The drive consists of a 100 hp single-stage impulse turbine capable of testing the unit up to the design speed of 10,000 rpm. Digital and analog computer programs were formulated to predict the steady-state and dynamic performance. Then, these computer programs were used to determine the affect of selected changes in the test assembly. Author

N68-34280*# Case Inst. of Tech., Cleveland, Ohio. Div. of Engineering.
LAMINAR FLOW ANALYSIS OF PLANE DISK SLINGER SEAL
Robert L. Rosenthal and Eli Reshotko Aug. 1968 125 p refs Presented at the APS Meeting, Toronto
(Grant NGR-36-003-064)
(NASA-CR-83016; FTAS/TR-68-14) CFSTI: HC $3.00/MF $0.65 CSCL 11A

The flow and temperature fields are considered in the region between a rotating and stationary disk. The governing equations are changed by a radial transformation into ordinary differential equations. Distinctions between regimes of large and small Reynolds numbers are clarified and the equations are solved accordingly. The trend toward boundary layer formation is confirmed by these solutions. The thermal problem is treated in a similar manner with Prandtl number also being of importance in this case. Finally, quantities which are of design importance are discussed based on the dynamic and thermal solutions. Author

N68-34321*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LUBRICANTS FOR INERTED LUBRICATION SYSTEMS IN ENGINES FOR ADVANCED AIRCRAFT
William R. Loomis, Dennis P. Townsend, and Robert L. Johnson Apr. 1968 30 p refs Presented at the Natl. Air Transportation Meeting, New York, 29 Apr.–2 May 1968; Sponsored by the Soc. of Automotive Engr.
(NASA-TM-X-61234) CFSTI: HC $3.00/MF $0.65 CSCL 11H

The feasibility of using presently available liquid lubricants in Mach 3 aircraft engines was investigated with a recirculating inerted lubrication system. Three fluids performed satisfactorily for short durations of three to ten hours in a full scale simulated aircraft bearing and seal assembly at an outer race bearing temperature of 700° F. The principal problem was with excessive leakage of the oil-side bellows face seals which accounted for a majority of the test terminations. With only one lubricant (a MIL-L-7808E oil) could bearing failure be blamed on a lack of lubricating ability. An inerted oil-mist once-through system was also tested but with less promising results with only one lubricant running successfully at 600° F bearing temperature. The mist system appears to be limited by its inability to maintain stable bearing temperatures, but it has enough potential to justify further study. Author

N68-34350# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
A REVIEW OF SELECTED NONDESTRUCTIVE TESTING ACTIVITIES AT BATTELLE NORTHWEST LABORATORY
D. C. Worlton 13 May 1968 29 p refs Presented at Inter-Am. Conf. on Mater. Technol., San Antonio
(Contract AT(45-1)-1830)
(BNWL-SA-1395) CFSTI: HC $3.00/MF $0.65

A review of the nondestructive testing facilities and equipment at Battelle-Northwest Laboratory is presented. Acoustic emission, eddy current, and critical angle ultrasonic methods of nondestructive testing are described. NSA

N68-34369# California Univ., Livermore. Lawrence Radiation Lab.
HIGH SPEED CATHODIC ETCHER
Wayne J. Steele 9 May 1968 6 p refs
(UCID-17327) CFSTI: HC $3.00/MF $0.65

The development of a high speed cathodic etcher used in the etching of uranium, uranium alloys, and brazes is reported. By employing recognized techniques and using certain modifications to meet new requirements, it was possible to construct a cathodic etcher having a minimum of variables to control. The new methods developed in handling the samples while within the etching chamber, and controlling temperatures, have greatly improved the entire process. Initial results of these experiments are outlined and discussed. Author (NSA)

N68-34370# Los Alamos Scientific Lab., N. Mex.
ELECTRO-MECHANICAL POLISHING OF SOME REFRACTORY CARBIDES CONTAINING GRAPHITE
T. I. Jones [1968] 12 p
(Contract W-7405-ENG-36)
(LA-DC-9602; CONF-680614-1)

Refractory carbides with associated graphite phases were polished using the electro-mechanical polishing technique. This method yields a surface with less flowed material than does standard mechanical polishing methods. The procedure was adapted for polishing graphite and predominately graphic matrices for optical microscopic examination. Author (NSA)

N68-34466# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF CAM MECHANISM PARAMETERS ON CAM PROFILE WEAR UNDER CONDITIONS OF PLASTIC CONTACT [VLIYANIE PARAMETROV KULACHKOVOGO MEKHANIZMA NA IZNOS PROFILYA KULACHKA V USLOVIYAKH PLASTICHESKOGO KONTAKTA]
E. I. Vorobev 12 Sep. 1967 15 p refs Transl. into ENGLISH from Mashinostr. (Kiev), no. 3, 1965 p 50–55
(FTD-HT-67-270; AD-672192)

The nature of the contact in machine parts, and, in particular, in a cam mechanism depends on the specific pressure, the microgeometry, and the properties of the material. Plastic deformations on friction surfaces have also been noted by many authors, even in quenched steels. Formulas are derived in the paper for the wear of a cam mechanism with several different types of contact. The formulas were verified directly by experiments on operating cam mechanisms. The formulas obtained support the basic conclusion of the paper that the normal wear of a cam profile is proportional to the loading acting on the higher kinematic pair of the cam mechanism, to a power greater than 1.5. Author (TAB)

N68-34563*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY EVALUATION OF GREASES TO 600°F AND SOLID LUBRICANTS TO 1500°F IN BALL BEARINGS
H. E. Sliney and R. L. Johnson [1968] 22 p refs Presented at the Ann. Meeting of the Am. Soc. of Lubrication Engr., Cleveland, 6–9 May 1968
(NASA-TM-X-61242) CFSTI: HC $3.00/MF $0.65 CSCL 11H

A special apparatus designed for the evaluation of high temperature lubricants in 20 mm bore ball bearings is described. The results of bearing runs at temperatures up to 1500 F in air are reported. Of the greases evaluated, a fluorocarbon grease, provided bearing lubrication for longer times at 450° and 600°F than either polyphenyl ether or silicon greases thickened with dyes and/or MoS_2. Cobalt alloy ball bearings, lubricated either with barium fluoride–calcium fluoride coatings bonded to the cages, or with porous metal cages impregnated with these fluorides, ran successfully at 1200° and 1500°F under a thrust load of 30 pounds and at a shaft speed of 5000 rpm. Author

N68-34577*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MECHANICAL PROPERTIES OF METALS AND FABRICATION IN NONREACTIVE ENVIRONMENTS
H. T. Sumsion Jun. 1968 39 p refs Presented at the Am. Vacuum Soc. Meeting, Beverly Hills, Calif., 10–13 Jun. 1968
(NASA-TM-X-61203) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Gas-metal interactions that occur in ambient environments and their effect upon mechanical properties of metals are briefly reviewed. Differences in mechanical properties measured in vacuum and in air or other gaseous environments are discussed in terms of type of test, basic processes of metal deformation and fracture involved, and possible reaction mechanisms. A concept of protective coatings to prevent gas-metal surface reactions and the specific effects of such coatings on fatigue properties of several metals are shown. The environmental effects are related to the problems of fabrication and end use. Author

N68-34595# California Univ., Berkeley. Lawrence Radiation Lab.
IMPURITY EFFECTS IN SINTERING LEAD ZIRCONATE TITANATE
Gary Alan Pryor (M.S. Thesis) May 1968 46 p refs
(Contract W-7405-ENG-48)
(UCRL-18191) CFSTI: HC $3.00/MF $0.65

Investigations into the effects of ball milling impurities on the sintering of lead zirconate titanate (PZT) were conducted. Varying amounts of Al_2O_3 and SiO_2 were added to a high purity, fine particle size powder obtained from special processing. Alumina additives were found to increase sintering by forming a liquid aluminate phase which wet the PZT grains and inhibited grain growth. Silica additives had a smaller effect on sintering than alumina. The formation of a siliceous liquid which did not wet the PZT grains and did not inhibit grain growth was observed. The optical microscope, electron microprobe, and scanning electron microscope were used in the above analysis. A minor effect of atmosphere on sintering was observed indicating that gas entrapment in closed pores during sintering may occur and leads to low densities. It is concluded that liquid phases make a major contribution to the sintering of lead zirconate titanate. Author (NSA)

N68-34599# European Atomic Energy Community, Brussels (Belgium).
ISOSTATIC HOT-PRESSING: A NEW POWDER METALLURGY COMPACTION PROCESS
H. Bumm, F. Thuemmler, and P. Weimar [1968] 22 p refs Transl. into ENGLISH from Kernforschungszentrum Rept. KFK-708, Jan. 1968
(EURFNR-473; EUR-3717) CFSTI: HC $3.00/MF $0.65

A description is given a new type of compaction process for powders, namely, isostatic hot compaction. The process is effected at high temperature and pressures in an autoclave. The specimens are located in a thin-walled metal container which transmits the isostatic gas pressure to the powder, thus bringing it to theoretical compactness. A plant was developed, constructed and tested up to 1600°C and 1000 atm over-pressure. The physical nominal values of some of the specimens hot-pressed were measured and compared with values from the bibliography. Author (NSA)

N68-34631# Naval Postgraduate School, Monterey, Calif.
A METHOD FOR COMPUTING LOWER CONFIDENCE LIMITS ON SYSTEM RELIABILITY USING COMPONENT FAILURE DATA WITH UNEQUAL SAMPLE SIZES
Jack R. Borsting and W. Max Woods Jun. 1968 28 p
(NPS-55Wo/Bg8061A; AD-672322)

A method is presented for constructing system reliability using component failure data when the sample sizes for testing on the component parts differ greatly. The procedure can be applied to weapons systems as easily as subsystems. No assumptions about failure distributions are made. The accuracy of the procedure was examined by computer simulations and in this manner the procedure has demonstrated high accuracy for cases of practical interest. Author (TAB)

N68-34688# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
STUDY OF FREQUENCY RESPONSE OF SHEFFIELD ELECTROJETS
Charles H. Jacobson and Robert R. Moore 10 Jun. 1968 3 p
(Contract AT(29-1)-1106)
(RFP-1034) CFSTI: HC $3.00/MF $0.65

Experiments were undertaken to test the limits of frequency response in a Sheffield Electrojet device. Specific application related to measurement of lathe spindle runout at high speeds (about 2000 revolutions per minute). Findings show the response will be accurate to driving frequencies of 30 cycles per second, as compared to normally used maximums of one cycle per second. Such capability suggests possible applications in other related work efforts. Author (NSA)

N68-34738# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A FIVE-BALL FRICTION MACHINE FOR STUDY OF LUBRICATING MATERIALS [PYATISHARIKOVAYA MASHINA TRENIYA SLYA ISSLEDOVANIYA SMAZOCHNYKH MATERIALOV]
K. I. Klimov and V. A. Mikheev 12 Sep. 1967 13 p refs Transl. into ENGLISH from Neftepererabotka i Neftekhim., Nauchn.-Tekhn. SB. (Moscow), no. 3, 1964 p 31–34
(FTD-HT-67-283; AD-672368)

With high-temperature and high-speed conditions outstripping the qualifications of mineral oil and plastic lubricating materials, especially because of a lack of high-temperature stability, and since extensive research in this area is lacking, even the research methods have not yet been developed. Four-ball friction machines are unsatisfactory by virtue of the time necessary for completing experiments; the authors therefore constructed a five-ball friction machine applicable to cases of rolling friction, sliding friction, or both. Author (TAB)

N68-34770*# Automation Industries, Inc., Boulder, Colo. Research Div.
DEVELOPMENT OF THE ULTRASONIC DELTA TECHNIQUE FOR ALUMINUM WELDS AND MATERIALS Final Report
K. J. Hannah, B. T. Cross, and W. M. Tooley 15 May 1968 69 p refs
(Contract NAS8-18009)
(NASA-CR-61952; TR-68-25) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The Delta Technique is a unique, multi-crystal inspection method that is relatively insensitive to defect orientation. Internal weld defects including lack of penetration and lack of fusion were readily detected using this technique. This technique is capable of rapid scanning rates while providing a simultaneous and permanent record of the test results. Test demonstrated that the Delta Technique successfully detected the weld defect of primary concern in 2014 and 2219 aluminum alloy weldments at inspection rates of 50 ft/hr. Lack of penetration of a 0.030" ×0.060" size and lack of fusion as narrow as 0.025" were reliably detected by the Delta Technique. Microfissuring, a laminar shrinkage type defect found in 3/16" and 1/4" weld sections was detected by the Delta Technique where radiographic techniques failed because of unfavorable defect orientation. Correlation of the nondestructive tests was made by destructively analyzing 18 feet of weld for total defect content. Results show that for a quantity of weldments containing tight lack of penetration up to 80% of the total defects were detected by the Delta Technique while only 36% of the total defects were detected with radiography. A manual Delta probe and a Delta wheel assembly were fabricated, and an evaluation of these configurations was made. Both the Delta wheel and the manual Delta probe provided the same quality of weld inspection obtained in previous studies. Author

N68-34797*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE ADHESION OF NICKEL USING AN ION BOMBARDMENT AND HEATING CLEANING TECHNIQUE
James M. Bradford, Jr. Jun. 1968 22 p refs Presented at the 1968 Vacuum Met. Conf., Beverly Hills, Calif., 10–13 Jun. 1968; Sponsored by the Am. Vacuum Soc.
(NASA-TM-X-61229) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Effects of oxygen recontamination, contact force, hardness, and temperature on the adhesion coefficient of nickel were studied using an ion bombardment and heating cleaning technique for metal joining of samples machined from polycrystalline nickel rod. A motor-driven linear motion feedthrough was used to bring the samples into contact and to make the adhesion couple as well as to move the samples apart to break the couple. The electron gun used in the cleaning had an axial magnetic field, and the path length of the ionizing electrons was increased by a reflector electrode. The technique was found applicable to the study of adhesion of clean nickel surfaces. The adhesion coefficient of the clean surface, reduced by even a partial monolayer of oxygen, was zero at an oxygen exposure of about 10^{-4} torr-sec, and inversely dependent on hardness of the nickel sample. It was relatively constant at about 0.2 for deformation ratios of less than unity and increased as the deformation ratios became greater than unity. M.W.R.

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N68-33635*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MICROWAVE PUMP REQUIREMENTS FOR FIELD OPERATIONAL BROADBAND RUTILE TRAVELING-WAVE MASERS

L. E. Rouzer Washington Sep. 1968 12 p refs
(NASA-TN-D-4764) CFSTI: HC $3.00/MF $0.65 CSCL 20E

This paper discusses microwave pump sources available for use in a field operational, rutile, broadband, traveling wave maser for the Applications Technology Satellite (ATS) program. Included is a brief resume of the current solid state microwave pump sources, klystrons, and the Hughes and OKI backward wave oscillators. The spin Hamiltonian for iron-doped rutile is given; its solution yields a pump frequency of 54.7 GHz and pump bandwidth of 500 MHz for a 4.065- to 4.195-GHz signal frequency. The suitability of the OKI backward wave oscillator for the application here considered has been determined; it is simple and comparatively inexpensive to operate in the field. The solid state modulator circuit capable of sweeping the OKI backward wave oscillator over 500 MHz is described; and the pump package, which maintains the tube temperature at 130°F (well within the operating range required by the tube) is discussed. Author

N68-33639 State Univ. of New York at Buffalo.
INTERACTION OF LASER RADIATION WITH GASES
John William Daiber (Ph.D. Thesis) 1967 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-13340

The interaction of a high-power, high-energy ruby laser with gases has been investigated. The operating principles of the laser are discussed and techniques are described which were developed for its reliable operation. The laser was used to produce electric breakdown in the gases and to subsequently heat this breakdown plasma. An analysis was made of the minimum laser power densities required to initiate the breakdown. The breakdown process was examined with both the microwave field theory and the free-free absorption theory. The predicted electric field strengths to produce breakdown were nearly the same for both models. With the microwave model the electron gains a little energy each collision and thus requires many collisions to gain a large amount of energy. The time required for all these collisions is the same time that is associated with the free-free absorption of an entire photon by the electron. Dissert. Abstr.

N68-33928 Polytechnic Inst. of Brooklyn, N. Y.
INVESTIGATIONS IN SPECTROSCOPY OF RUBY FOR LASER APPLICATIONS
Zindel Herbert Heller (Ph.D. Thesis) 1967 136 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-13393

The temperature-broadening of the principal fluorescent line R_1, of ruby, has been investigated to evaluate the possible wavelength accuracy of a ruby laser wavelength standard. It is suggested that the R_1-linewidth is caused by lifetime-shortening of the $\bar{E}(^2E)$ state by single-phonon transitions to higher energy states. The Einstein transition formulas and the Debye theory of phonon modes were applied to experimental R_1-linewidth data to compute low temperature line-breadths $\bar{\Gamma}_o$, and energies W_1 of the interacting states, from this model. Two interacting states were located, one with $\bar{\Gamma}_o \approx 155$ cm^{-1} and $W \approx 14,990$ cm^{-1}, and another with $\bar{\Gamma}_o \approx 1350$ cm^{-1} and $W \approx 16,700$ cm^{-1}, in good agreement with the observed $^2T_1$ and $^4T_2$ multiplets. Dissert. Abstr.

N68-34255*# Stanford Univ., Calif. Microwave Lab.
INVESTIGATION OF LASER DYNAMICS, MODULATION AND CONTROL BY MEANS OF INTRA-CAVITY TIME VARYING PERTURBATION Semiannual Status Report, 1 Feb.–31 Jul. 1968
S. E. Harris Aug. 1968 18 p refs
(Grant NGR-05-020-103)
(NASA-CR-98724; SU-ML-1676; SASR-5) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Studies concerned with attaining tunable optical sources by means of nonlinear optical techniques are discussed with emphasis on the development of a tunable visible cw optical parametric oscillator. Details are given on the successful operation and operating characteristics of a 5145 Å argon ion laser pumped parametric oscillator. Figures are given to show combined losses of the mirrors, crystal, and lens as a function of wavelength, and the mode sizes in the oscillator cavity as function of internal lens position. The bandwidth of oscillator was measured, and the temporal behavior of the oscillator was investigated. Measurements of the oscillator bandwidth by time averaged photographs is discussed along with an investigation of the temporal behavior of the oscillator. B.S.D.

N68-34485# Hughes Research Labs., Malibu, Calif.
A STUDY OF FUNDAMENTAL REQUIREMENTS FOR HIGH BRIGHTNESS RAMAN LASER STUDIES Final Report, 1 Oct. 1966–30 Jun. 1968
F. J. McClung Jun. 1968 83 p refs
(Contract N00014-67-C-0206; ARPA Order 306)
(AD-672328)

The report describes studies of stimulated Raman scattering (SRS) and nonlinear index effects in liquids composed of spherically symmetric molecules. It is concluded that although SRS can be observed without self-focusing, nonlinear index effects, presumably because of molecular redistribution, are present and should lead to beam instabilities at somewhat higher powers. Also described are studies of SRS in hydrogen gas pumped by a giant pulse ruby laser. Finally, a theoretical study of the third order polarizability applied to hydrogen, and the resulting coupled Stokes-anti-Stokes waves is described. Author (TAB)

N68-34566# General Telephone and Electronics Labs., Inc., Bayside, N. Y.
HIGH-ENERGY PULSED LIQUID LASER Semiannual Technical Summary Report, 1 Jan.–30 Jun. 1968
H. Samelson, A. Lempicki, and A. Brecher 30 Jun. 1968 41 p refs
(Contract N00014-68-C-0110)
(TR-68-826.4; AD-672323)

The study of high-energy liquid lasers has advanced in all aspects: material, physical and device. Improvements have been made in the $SeOCl_2$ host medium, and a new $POCl_3$ host medium has been developed. The properties of the alternating-flow system have been studied, new components developed, and a closed circulating system has been constructed. Outputs of over 32 joules have been achieved in a static system, and preliminary comparisons of $POCl_3$ and $SeOCl_2$ have been made. The Q-switching and mode-locking phenomena have been studied, and a number of new nonlinear effects observed. Author (TAB)

N68-34662# Laboratoire Suisse de Recherches Horlogères, Neuchatel (Switzerland).
ATOMIC HYDROGEN MASER WORK AT L.S.R.H. NEUCHATEL, SWITZERLAND
C. Menoud, J. Racine, and P. Kartaschoff [1967] 28 p refs
Presented at 21st Ann. Freq. Control Symp., Fort Monmouth, N. J., 24–26 Apr. 1967
CFSTI: HC $3.00/MF $0.65

A pair of atomic hydrogen masers is operating at the L.S.R.H. since spring 1966. The masers, the all-solid-state receiver and the measurement systems are herewith described. First results of measurements of the relative frequency stability between the two masers, wall shift determination and cesium-hydrogen comparisons are given. Author (ESRO)

N68-34676*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OPTICAL TECHNOLOGY FOR EXPERIMENTS AND APPLICATIONS IN CISLUNAR SPACE

H. H. Plotkin [1967] 25 p Presented at the NASA/EIA Briefing on Aerospace Electron. Systems Technol., Cambridge, Mass., 3-4 May 1967
(NASA-TM-X-59786) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Discussed is the application of tracking satellites with pulsed and continuous lasers for studies of atmospheric properties and experiments in optical space communications. A pulsed ruby laser radar system on the satellite, boresighted with the camera, can determine its altitude above the earth surface with a precision of two meters. Pulsed laser ranging can also be used for precise measurements of the moon's motion. Large orbiting telescopes will give excellent optical performance since the degrading atmospheric effects are absent; a 3-meter diameter astronomical telescope in orbit would have an angular size image (at 5000 Å) of 4 ± 10^{-7} radians, or 0.08 seconds of arc. G.G.

N68-34718# Honeywell, Inc., Hopkins, Minn. Corporate Research Center.
MECHANISMS OF LASER SURFACE INTERACTIONS Final Report
J. F. Ready, E. Bernal G, and L. T. Shepherd May 1968 75 p refs
(Contract DA-18-001-AMC-1040(X))
(AD-672093)

This report describes extensions of measurements of particle emission produced in the interaction of high power laser radiation with absorbing surfaces. Most of the experimental work in this report period involved the use of a hemispherical interaction chamber with collectors around the periphery. A multiplier detector and a bipolar detector have been employed in addition to the ordinary disc collectors used previously. The experimental results for a tungsten target and a laser flux density of the order of 50 megawatts/sq. cm. indicate that the blowoff material consists of a mixture of neutral molecules and of a plasma containing approximately 10 to the 13th or 14th power electrons and ions. Secondary electron emission from the collector surfaces bombarded by the incident heavy particles is important in producing the observed signals. Temperature of the expanding material is of the order of 10 eV. Additional work has been devoted to measuring the optical emission from glass samples heated by a CO2 laser beam and also to an investigation of the possible presence of picosecond pulses in our laser output. Author (TAB)

N68-34735*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
LASER SATELLITE-TRACKING SYSTEM Progress Report, 1 Feb.–1 Jul. 1968
Aug. 1968 25 p
(Contract NSR-09-015-039)
(NASA-CR-96739; PR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Research and experimentation with a prototype laser system are described. Initial range measurements were made on laser satellites to test the laser transmitter and to evaluate the combined performance of the system. The major components of the ranging system are described in detail. Test data, ranging observations, and problems encountered during the testing are also discussed. K.W.

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N68-33611 National Lending Library for Science and Technology, Boston Spa (England).
INVESTIGATION OF THE SURFACE CORROSION STRUCTURE OF Cu-Ni ALLOYS BY THE METHOD OF MEASURING THE WORK FUNCTION OF AN ELECTRON AFTER ATTACK BY 18% AMMONIA SOLUTION
V. V. Skorchelletti, I. A. Makknovetskaya, and S. S. Kotova 29 Jul. 1968 4 p ref Transl. into ENGLISH from Zh. Prikl. Khim. (Moscow), v. 41, no. 3, Mar. 1968 p 651-652 In ENGLISH and RUSSIAN *Its* Transl. 68/194
Available from Natl. Lending Library, Boston Spa, Engl.

To determine the variation of the work function for alloys exposed to aggressive medium which does not give a clear stability limit, corrosion tests of Cu-Ni alloys in 18% NH_3 solution were studied. Corrosion tests in 18% NH_3 solution demonstrated that pure nickel and alloys with up to 75 to 80 at.% Ni exhibit a very low corrosion rate which steadily increases with rising copper content. In contrast to tests in 5% NH_3 solution, nickel and nickel-rich alloys exhibited a definite, although low, corrosion rate. It was further found that exposure to 18% NH_3 solution affects the shape of the work function versus alloy composition curve only in the nickel part of the system. Data presented indicate that: (1) the curve of the work function after etching shows a correlation with the corrosion rate versus alloy composition curve, and (2) in a strongly aggressive medium, in which nickel is subject to corrosion, the enrichment of the surface in nickel occurs only for alloys containing more than 75 to 80 at.% Ni. Results confirm the hypothesis that there exists a correlation between the electron work function after brief exposure to ammonia solution and the limit of chemical stability of copper-nickel alloys. S.C.W.

N68-33618 National Lending Library for Science and Technology, Boston Spa (England).
ELECTRODEPOSITION OF PALLADIUM-NICKEL ALLOYS
S. N. Vinogradov and N. T. Kudryavtsev 29 Jul. 1968 16 p refs Transl. into ENGLISH from Zashchita Metal. (Moscow), v. 4, no. 2, Mar.–Apr. 1968 p 145–151 In RUSSIAN and ENGLISH *Its* Transl. 68/165
Available from Natl. Lending Library, Boston Spa, Engl.

A study was made of the effect of electrolyte composition and electrolysis parameters on the current yield, contact resistance, internal stresses, microhardness and wear resistance of cathodic Pd–Ni deposits. It is shown that, with increasing nickel content of the alloy, internal stresses in deposits decrease and the microhardness and wear resistance of the latter increase. Thus, the microhardness and wear resistance of an alloy containing 25% nickel are, respectively, 1.5 and 14 times higher than those of pure palladium. The wear resistance of the alloys is strongly affected by temperature, electrolyte acidity, and current density; the microhardness is only negligibly influenced by these factors. In the simultaneous deposition of nickel and palladium ions, the discharge of palladium ions is hindered and that of nickel ions facilitated. The optimum electrolyte composition and electrolysis parameters are given for obtaining bright deposits containing 20% to 25% nickel. Author

N68-33656 Case Inst. of Tech., Cleveland, Ohio.
HYDROGEN EMBRITTLEMENT OF MARAGING STEEL
Hugh R. Gray (Ph.D. Thesis) 1967 68 p
Available from Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 67-16074

The initial distribution of electrolytically induced hydrogen in 300 maraging steel and its subsequent redistribution and homogenization during annealing have been studied with electrical resistivity techniques. These data indicate that a substantial amount of hydrogen, up to 1-2 ppm, can exist in true interstitial, solid solution at ambient temperatures. The effect of deformation on the alteration of the initial hydrogen distribution has been characterized by resistivity methods and has been correlated with embrittlement behavior determined by tensile ductility measurements. An increased

density of line and point defects formed by prestressing alters the initial hydrogen distribution by depleting the lattice of interstitial hydrogen. This trapped hydrogen is innocuous and normally brittle steel will exhibit essentially full recovery of ductility after prestressing. Dissert. Abstr.

N68-33684*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REFRACTORY METAL FIBER NICKEL BASE ALLOY COMPOSITES FOR USE AT HIGH TEMPERATURES
Donald W. Petrasek, Robert A. Signorelli, and John W. Weeton Washington Sep. 1968 48 p refs Presented at the Soc. of Aerospace Mater. and Process Engr. 12th Natl. Symp. on Advan. in Structural Composites, Anaheim, Calif., 10–12 Oct. 1967
(NASA-TN-D-4787) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The stress rupture properties of several refractory metal fiber–nickel base alloy composites were determined at 2000° and 2200°F. The effect of wire diameter, fiber content, fabrication history and compositions of the matrix and fiber on the stress rupture properties of the composite was determined. The 100-hour stress rupture strength obtained for the strongest composites tested at 2000° and 2200°F was 35,000 and 14,000 psi, respectively. Composite strength was related to the compatibility of the fibers with the matrix materials. Composite rupture strength can be optimized by proper fiber diameter selection. Author

N68-33755 Michigan Univ., Ann Arbor.
THE PLASTIC DEFORMATION OF MAGNESIUM
Eugene Wallace Kelley (Ph.D. Thesis) 1967 99 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-15645

Deformation studies have been conducted at room temperature on single crystals and textured polycrystals of magnesium and magnesium alloys with thorium and with lithium. Single crystals oriented to suppress shear on the easily activated basal slip systems were deformed by plane-strain compression. Compression along the c-axis was accommodated by $\{10\bar{1}1\}$ banding. Compression perpendicular to the unconstrained c-axis activated $\{10\bar{1}2\}$ twinning, and, after virtually complete twinning, deformation continued by $\{10\bar{1}1\}$ banding in the twinned material. Fracture in all materials occurred parallel to $\{11\bar{2}4\}$ or $\{10\bar{1}1\}$ depending on the orientation and composition of the specimen. Anisotropy of strength in textured polycrystals was determined in uniaxial compression and tension as well as plane-strain compression. The results are correlated with the orientation texture and the deformation modes observed in single crystals, and have been used to establish yield loci for the materials. Dissert. Abstr.

N68-33783 Case Inst. of Tech., Cleveland, Ohio.
EFFECT OF SOLIDIFIED STRUCTURES ON MECHANICAL PROPERTIES OF CAST HIGH TEMPERATURE ALLOYS
Delmar O'Daniel Stanley (Ph.D. Thesis) 1967 125 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-16104

Effects of additions that have the potential of refining the structure of conventionally and directionally solidified castings of a medium and high carbon austenitic steel and of a high carbon Stellite material were investigated. The change in the columnar zone length and secondary dendrite spacing resulting from these additions was measured to determine their refining effectiveness. The influence of titanium additions on the hot workability of the medium carbon steel and on the tensile and stress-rupture properties of the high carbon steel and Stellite was determined. Titanium additions to all three materials and boron and rare earth additions to the Stellite reduced both the columnar zone length and dendrite spacing. Zirconium additions to the Stellite and boron, rare earth, vanadium and zirconium additions to the high carbon steel reduced the dendrite spacing but had little effect on the columnar zone length. Dissert. Abstr.

N68-33826 Case Inst. of Tech., Cleveland, Ohio.
THE TEMPERATURE AND STRAIN RATE DEPENDENCE OF THE DEFORMATION CHARACTERISTICS OF AUSTENITIC STAINLESS STEELS
William McCandless Cain, III (Ph.D. Thesis) 1967 62 p
Available from Univ. Microfilms: HC 3.60/Microfilm $3.60 Order No. 67-16063

The ductility and the stress-strain behavior of seven austenitic stainless steels have been determined over a range of strain rates from .02 to 100 inches/minute, and over a range of temperatures from 77 to 300°K. Measurements of the progress of austenite/martensite transformation in the less stable alloys were also made. This permitted a correlation of ductility behavior with stacking fault energy, degree of transformation, work hardening rate, fracture strength, and other deformation characteristics. The results suggest that ductility variations in these stainless steels cannot be interpreted in terms of a simple thermally-activated mechanism such as cross slip. Dissert. Abstr.

N68-33858 Aeronautical Research Inst. of Sweden, Stockholm.
FATIGUE TESTS ON A 5% Cr-STEEL [UNDERSOEKNINGENS ANDAMAL OCH OMFATTNING]
[1968] 43 p refs In SWEDISH; ENGLISH summary
(HU-1132) CFSTI: $3.00

Fatigue tests were carried out on specimens with circular cross-section of vacuum melt 5% Cr-steel corresponding to AISI Type H11-Modified (SAAB designation 1656-4 and −5) heat-treated to two different values of ultimate strength, viz. 170 and 180 kg/mm^2. Both unnotched specimens and specimens with U-notch ($K_t = 1.8$) were tested. The specimens were first rough turned and then heat-treated to desired ultimate strength. After this the specimens were fine turned to the required dimensions. The notches were obtained by grinding. The effect of shot-peening on the fatigue strength was studied for notched specimens and also the effect of chronium-plating on unnotched specimens. The main portion of the tests was carried out with an alternating tensile-compressive loading with a mean stress of zero but in some cases fatigue tests were also performed with mean stresses of +40 and −40 kg/mm^2. The results from the fatigue tests are presented in the form of S-N-curves and High-diagrams. The results show that shot-peening had no influence at all on the fatigue strength of notched specimens and that the chromium-plating of unnotched specimens had a deteriorating influence on the fatigue strength. However, this reducing effect can be partly eliminated by cold-working the specimens by rolling before chroming. Author

N68-33859 Aeronautical Research Inst. of Sweden, Stockholm.
FATIGUE TESTS ON AN 18% Ni MARAGING-STEEL [UTMATTNING MED HOEGHALLFAST STALSMIDE 1383-5 (BOFORS (MAR 2)]
[1968] 25 p refs In SWEDISH; ENGLISH summary
(HU-1071)

The investigation comprises fatigue tests on specimens of circular cross-section of vacuum melt 18% Ni Maraging-steel (SAAB designation 1383-5). Both unnotched specimens and specimens with an U-notches ($K_t = 1.8$) were tested. The specimens were first rough turned, leaving an 0.4 mm thickness of material for the final finishing process. After this, the specimens were heat-treated, and fineground to the dimensions required. The unnotched specimens were polished after grinding, while the notched specimens were not polished. In the fatigue tests the specimens were subjected to tensile and/or compressive axial loads and S-N curves were determined for the mean stresses, −40, and +40 kg/mm^2. The static ultimate tensile strength for the unnotched specimens was 183 kg/mm^2 and for the notched specimens about 280 kg/mm^2. For a life, N, of 10^7 load cycles the endurance limit obtained for alternating loading with a mean stress of zero was about ±55 kg/mm^2 for unnotched specimens and about ±32 kg/mm^2 for notched specimens. Author

N68-33968 Northwestern Univ., Evanston, Ill.
VOLUME AND GRAIN BOUNDARY DIFFUSION DURING SINTERING AND THE SINTERING KINETICS OF NICKEL
Lloyd Berrin (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-15189

Precise analytical relationships between the surface geometry and the shrinkage or neck growth between sintering spheres and a sphere on a plate have been determined. The initial stage sintering kinetics of impure and high purity nickel powders were studied by measurements of the isothermal shrinkage of powder compacts. Computer methods were devised to analyze the data. Sintering of both grades of nickel powder proceeded by essentially a volume diffusion mechanism, yet their sintering behavior was markedly different. The sintering kinetics of the impure nickel was described by the diffusion coefficient, $D = 1.028 \exp(-58.7 \times 10^3/RT)$. A value of 61.6 Kcal/mole was calculated for the activation energy for sintering of the high purity nickel. The results were inconclusive as to the effect of grain boundary diffusion during the sintering of nickel. Dissert. Abstr.

N68-33981# Bhabha Atomic Research Centre, Bombay (India). Metallurgy Div.
THERMAL ACTIVATION IN ZIRCONIUM-CARBON ALLOYS
P. Das Gupta and V. S. Arunachalam 1968 21 p refs
(BARC-325) CFSTI: HC $3.00/MF $0.65

The effect of temperature and strain-rate on the yield and flow of zirconium containing about 1.4 at % carbon has been examined at different temperatures between 77°K and 700°K. The above measurements were coupled with strain-rate change tests so that all the deformation parameters associated with thermal activation could be evaluated. The results of these measurements showed that in pure iodide zirconium (principal impurity: 0.09 at %O), the thermal component of flow stress and its activation energy are increased with the addition of carbon. This effect is strongly felt only during the first stage of thermal activation where impurities are rate-controlling. At higher temperatures, where the Peierls–Nabarro force is likely to be rate-controlling, the effect of carbon is negligible. With impure zirconium containing large concentration of interstitials (≈ 1 at % O), addition of carbon does not alter the activation parameters associated with the thermally activated deformation significantly. This is discussed on the basis of the potency of carbon as a hardener compared to oxygen. Author

N68-33984# Siemens and Halske A. G., Munich (West Germany).
DIFFUSION COEFFICIENT OF HYDROGEN IN PALLADIUM ALLOY ELECTRODES
Jacques Bersier and Albrecht Kuessner [1968] 10 p refs
CFSTI: HC $3.00/MF $0.65

The diffusion coefficient of hydrogen in palladium alloys has been determined both as a function of the hydrogen concentration and of the temperature in the range of 30° to 300°C. An equation is developed for the variation of the diffusion coefficient with the hydrogen concentration from zero to a minimum value of the curve. Author

N68-34037*# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
THE INITIATION OF HOT-SALT STRESS CORROSION CRACKING OF TITANIUM ALLOYS
S. P. Rideout [1967] 21 p refs Presented at the ASTM Symp. on Applications Related Phenomena in Titanium Alloys, Los Angeles, 18–19 Apr. 1967 Submitted for publication Prepared for AEC
(NASA Order R-124)
(NASA-CR-88069) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The initial stages of hot salt stress corrosion cracking of titanium alloys were studied using hot stage microscopy and cinematography. An incubation period for cracking was observed, the duration of which depends on exposure temperature, salt composition, and alloy composition. For Ti-8Al-1Mo-1V exposed to NaCl the incubation period decreased from about 96 hours at 475°F, to 20 hours at 500°F, to 1-1/2 hours at 650°F, to only 10 minutes at 850°F. This same alloy cracked severely in only 20 minutes at 475°F when exposed to $SnCl_2$, indicating that the apparent threshold temperature for cracking is strongly influenced by chemical environment. At 650°F the incubation period for NaCl cracking of four alloys containing aluminum increased with decreasing aluminum content. Moisture was demonstrated to be a vital ingredient in hot salt attack and the presence of absorbed hydrogen in salt corroded areas has been demonstrated using radiotracer H 3(tritium). Author

N68-34204*# Du Pont de Nemours (E. I.) and Co., Aiken, S. C.
THE ROLE OF MOISTURE AND HYDROGEN IN HOT-SALT CRACKING OF TITANIUM ALLOYS
S. P. Rideout, R. S. Ondrejcin, M. R. Louthan, Jr., and D. E. Rawl [1967] 41 p refs Submitted for publication
(NASA Order R-124; Contract AT(07-2)-1)
(NASA-CR-89805) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The role of moisture and hydrogen in the stress corrosion cracking of Ti-8Al-1Mo-1V exposed to hot chloride salts was investigated. The adsorption and retention of moisture during the application of salt deposits and subsequent heating, and the extent of HCl and hydrogen generation during corrosion were studied using radiotracer techniques and mass spectrographic analyses of volatile corrosion products. Hot-stage microscopy and cinematography were used to study crack initiation and propagation, and the characteristics of fracture surfaces were examined by electron fractography. The effects of NaCl were compared to those of $SnCl_2 \cdot 2H_2O$, which not only retains much more moisture but also has a much lower melting point than NaCl. These studies revealed an obvious association between the occurrence of cracking and the amounts of Hcl and hydrogen generated during hot salt corrosion. The observations are consistent with a stress-sorption mechanism for cracking, in which corrosion-produced nascent hydrogen is proposed to be the sorbed species responsible for cracking. Author

N68-34267# Atomics International, Canoga Park, Calif.
LITERATURE SURVEY OF HYDROGEN EFFECTS ON NICKEL-BASE MATERIALS
W. M. Robertson 6 Sep. 1967 5 p refs
(NAA-SR-MEMO-12554) CFSTI: HC $3.00/MF $0.65

The literature indicates that hydrogen at low pressure can increase the creep rate of nickel-base materials. At high pressure (several hundred atmospheres) and high temperatures, hydrogen can also appreciably reduce the ductility of nickel-base materials. It is concluded that Hastelloy-N, as tested for the SDR program, should not show any appreciable reduction in ductility due to hydrogen. Author (NSA)

N68-34274# Istituto Elettrotechnico Nazionale (Galileo Ferraris), Turin (Italy). Centro Ricerche Nucleari.
INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION Quarterly Report, 1 Oct.–31 Dec. 1967
F. S. Rossi Saluggia, Italy Soc. Ric. Impianti Nucl. May 1968 9 p ref
(Contract EURATOM-074-65-10 TEEI(RD))
(M/551; EURAEC-2037; EUR-3987; QR-9) CFSTI: HC $3.00/MF $0.65

Work done under the research contract 074-65-10 TEEI (RD) in the Istituto Elettrotecnico Galileo Ferraris during the quarter October 1–December 31, 1967, 1967, is reported. Information is included on radiation damage recovery studies by annealing treatments under magnetic fields, interactions of C and N with defects

introduced by neutron irradiation, and on magnetic properties of Permalloy irradiated in different positions with reference to the reactor core. Author (NSA)

N68-34289# Oak Ridge National Lab., Tenn.
SOURCES OF CONTAMINATION DURING ELECTRON-BEAM MELTING
R. E. Reed, C. W. Dean, R. E. McDonald, and J. F. Emery Jul. 1968 20 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2208) CFSTI: HC $3.00/MF $0.65

High-purity niobium was electron beam melted and drop cast at a furnace chamber pressure of 5×10^{-6} torr. Before melting, a neutron activation analysis showed: 84 ppM Ta, 4 ppM W, and <1 ppM hafnium. After melting, using a tantalum (T-111 alloy) emitter, the analysis showed: 564 ppM Ta, 50 ppM W, and 413 ppM Hf. At first it was believed that the contamination was coming from the emitter. New batches of niobium were melted using niobium and thoriated tungsten emitters. However, all melts still showed considerable contamination. An investigation revealed that the contamination was being volatilized from the furnace walls by the radiant energy from the beam. After cleaning the chamber, another melt using a T-111 alloy emitter resulted in a metallic impurity content of 115 ppM Ta, 5 ppM W, and <10 ppM Hf. The various sources of contamination during melting are discussed, and the importance of keeping the furnace chamber clean is emphasized. Author (NSA)

N68-34366# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
INHIBITION OF STRESS CORROSION CRACKING WITH PHOSPHATE SOLUTIONS
Alvin P. Larrick Apr. 1968 22 p refs
(Contract AT(45-1)-1830)
(BNWL-753) CFSTI: HC $3.00/MF $0.65

Autoclave tests were conducted for an eight month period to compare the corrosiveness and stress-corrosion cracking inhibition qualities of alternate N Reactor steam generator secondary system water chemistry to that of the zero solids (hydrazine-morpholine) water treatment presently used. Seven tests with phosphate levels from 0 to 1000 ppM, sulfite levels from 0 to 100 ppM, hydrazine levels from 0 to 15 ppM and morpholine levels of 2 ppM were conducted. Stress corrosion cracking of 304 SS tubing obtained from an N Reactor steam generator occurred in both the liquid and vapor phases of solutions not containing phosphates, and in the vapor phase over solutions containing phosphate, but not on samples immersed in the liquid phase of any solution containing phosphate ion. At six months exposure one small 10 mil long crack was noted on a sample in the liquid phase of the solution containing 1000 ppM phosphate, 15 ppM hydrazine; at eight months exposure similar cracks were noted on a sample from this solution and from a sample containing 1000 ppM phosphate, 100 ppM sulfite. Cracks were not found on samples in the liquid phase of three other solutions containing 50 to 100 ppM phosphate. Large cracks were found on samples in the liquid phase of solutions without phosphate and on samples in the vapor phases of most solutions. The phosphate solutions provided cracking inhibition under extremely adverse conditions since the solutions were contaminated with chlorides and oxygen, elements which provide an environment very conducive to stress-corrosion cracking. Stress-corrosion cracking did not occur on other lots of unsensitized 304 SS and 304 SS heat treated similarly to the steam generator tubing nor did it occur on Inconel 600, Incoloy 800 or A212 CS. Weight losses on the stainless steel, Inconel and Incoloy samples were negligible. Total penetration on the carbon steel after 8 months ranged from 0.02 to 0.3 mils in the various solutions. Author (NSA)

N68-34384# Metaalinstituut TNO, The Hague (Netherlands).
FORGING TESTS WITH MARAGING STEEL [SMEEDPROEVEN AAN MARAGING STAAL]
H. P. Pouw and J. W. Schinkel 25 Apr. 1968 19 p refs In DUTCH
(M-68-310; TDCK-50858)

Hot drawing and shear tests were conducted with a vacuum-melted maraging steel of a quality used in the manufacture of drive shafts. The tests were made to study the problems of the high resistance to deformation due to the high Ni, Co, and Mo contents, the tendency of grain growth at high temperatures, and the effect of carbide and nitride precipitations on the austenite grain boundary with the resulting reduction in notch toughness. Deformation forces and extent of deformation were measured, and the effect of the deformation on the microstructure was metallographically determined. Transl. by K.W.

N68-34392# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
KINETICS AND MECHANISM OF OXIDATION OF BINARY ALLOYS OF NICKEL WITH TITANIUM [KINETIKA I MEKHANIZM OKISLENIYA BINARNYKH SPLAVOV NIKELYA S TITANOM]
A. V. Guts and A. Tumarev Sep. 1967 16 p ref Transl. into ENGLISH from Tr. Leningr. Politekhn. Inst. (Moscow), no. 251, 1965 p 70–75
(FTD-HT-67-265; AD-672339)

A series of nickel-titanium alloys containing from 0.53 to 16.7% Ti were studied to clarify the high temperature behavior of this system. A survey of earlier work revealed discrepancies in the oxidation behavior of Ni-Ti, probably due to the presence of other elements. In this study the base materials were of high purity (99.85% Ni and 99.25% Ti). Kinetic data were obtained by noting weight gain during oxidation. Author (TAB)

N68-34399*# Boeing Co., Seattle, Wash. Aerospace Group.
CYCLIC AND SUSTAINED LOAD FLAW GROWTH CHARACTERISTICS OF 6AL-4V TITANIUM Final Report
J. N. Masters Jul. 1968 66 p refs
(Contract NAS9-7637)
(NASA-CR-92231; D2-114298-1) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Plane-strain cyclic and sustained load flaw growth characteristics were evaluated for 6Al-4V titanium solution treated and aged forgings and weldment heat affected zones (HAZ). Cyclic load tests on both base metal and HAZ were performed at room temperature in air. Sustained load tests were performed on base metal in the environment of nitrogen tetroxide containing nitric oxide contents ranging from about 0.30% to 0.65%. These tests were performed at 70° and 90°F. Results of cyclic flaw growth data obtained are presented as represented both by a least square fit of the data from data points, as well as a 99% lower confidence line of the data. It is shown that of three forging heats investigated test scatter between heats is not important. Results of sustained load tests in nitrogen tetroxide show that threshold stress intensity ratios increase steadily with increasing nitric oxide content. It is concluded that an increase in the existing lower limit of nitric oxide content (presently set at 0.40% by NASA specification) would be beneficial to service life of titanium vessels. Author

N68-34449# Battis Atomic Power Lab., Pittsburgh, Pa.
PREDICTIONS OF TENSILE PROPERTIES AT TEMPERATURES OTHER THAN THE TESTING TEMPERATURE
J. G. Goodwin and W. L. Davis May 1968 18 p
(Contract AT(11-1)-GEN-14)
(WAPD-TM-767) CFSTI: HC $3.00/MF $0.65

A statistical method has been devised whereby the tensile properties of a material at a temperature other than the testing

temperature can be accurately estimated by testing at only one temperature. The method involves the establishment of prediction equations over the temperature range of interest and the computation of confidence and tolerance intervals by techniques presented. The tensile properties of Zircaloy-2 are used to illustrate the method; however, the technique is applicable to any material, providing the guidelines cited in the text are observed. Author (NSA)

N68-34495*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MATERIALS TESTING IN A VACUUM ENVIRONMENT
Howard G. Nelson Jun. 1968 60 p refs Presented at the Am. Vacuum Soc. Meeting, Beverly Hills, Calif. 10–13 Jun 1968
(NASA-TM-X-61202) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Some general problem areas of materials testing in a vacuum environment are discussed in terms of component equipment with reference to specific requirements. These problem areas include: (1) the selection of a vacuum pumping system, as related to surface contamination, (2) pressure requirements as related to the particular materials test, (3) pressure measurement and residual gas composition analysis, (4) measurement of the investigative parameter when tests are conducted in a vacuum, (5) specimen thermal control at high and low temperatures in vacuum, (6) electrical, fluid, and motion transmission through a vacuum chamber wall. Selected case histories of vacuum apparatus, as applied to a particular materials test, are discussed. Also, when possible, the types of measurements made with each apparatus are presented. The systems discussed include zone-refining and monocrystal growing apparatus; tensile, fatigue and creep testing apparatus; cold-welding or adhesion apparatus; a combined space environment system; as well as vacuum applications to research instruments such as the electron microscope. Author

N68-34499# Army Materials and Mechanics Research Center, Watertown, Mass. Interdisciplinary Research Lab.
PRECIPITATE DISSOLUTION AND ITS DEPENDENCE ON GROWTH MODE
Howard B. Aaron May 1968 28 p refs
(AMMRC-TR-68-12; AD-672067)

A model is presented for the dissolution of a precipitate in which solute transfer occurs by volume diffusion of material away from the precipitate in the matrix. The predicted dependence of dissolution kinetics on growth mode is a consequence of the fact that the concentration profile ahead of a growing precipitate is a function of the diffusion path. Author (TAB)

N68-34546# Value Engineering Co., Alexandria, Va.
METALLURGICAL EVALUATION OF AIRCRAFT EXHAUST SYSTEM COMPONENTS FAILED DURING GROUND TEST PROGRAM Final Report
J. R. Kaye, T. J. Hogland, and H. P. Weinberg Apr. 1968 72 p refs
(Contract FA-67-NF-210)
(NA-68-22; DS-68-10; AD-672034)

Twenty samples from small aircraft engine exhaust systems were investigated metallurgically to determine the differences, if any, between failures produced in a ground test program and failures from operating aircraft. The work included samples fabricated from a new material (nickel-iron-chromium alloy) recommended as an improvement for applications such as exhaust systems. The purpose also requested further information regarding the metallurgical cause of failure of conventional stainless steel exhaust system components. Author (TAB)

N68-34579# Bettis Atomic Power Lab., Pittsburgh, Pa.
ESTIMATED CREEP PROPERTIES OF ZIRCALOY DURING NEUTRON IRRADIATION (LWBR DEVELOPMENT PROGRAM)
F. A. Nichols May 1968 33 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-756) CFSTI: HC$3.00/MF$0.65

A comprehensive model is proposed to explain the creep of Zircaloy during neutron irradiation. The in-pile softening observed at low stresses is hypothesized to be due to the growth-directed Roberts–Cottrell yielding creep originally proposed for α-uranium, or the formation of point defect loops preferentially on certain planes in response to the applied stress (which may or may not be followed by yielding creep), or to a combination of these two mechanisms. The in-pile hardening observed at high stresses (or strain-rates) is proposed to be due to the cutting by dislocations of depleted zones as originally proposed to account for post irradiation hardening. In this stress (strain-rate) region, in-pile behavior is identical to post irradiation behavior. At intermediate stresses (strain-rates) a mechanism of radiation enhanced climb around depleted zones is suggested as being rate-controlling. As the stress is decreased, the climb process becomes easier and the rate is then controlled by glide at a flow stress characteristic of unirradiated, annealed material, it being proposed that radiation enhanced diffusion enables climbing around the normal strain hardening obstacles. At still lower stresses, this glide process becomes negligibly slow compared with the growth connected creep mechanism which is presumed to operate independently. The overall scheme is shown to be in good agreement with all the in-pile data presently available. Author

N68-34611# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
RECRYSTALLIZATION BEHAVIOR OF HAFNIUM
C. D. Calhoun and J. R. Fascia 4 Apr. 1968 31 p refs
(Contract W-31-109-ENG-52)
(KAPL-3353; UC-25) CFSTI: HC$3.00/MF$0.65

The recrystallization behavior of hafnium was investigated. Hafnium hot-worked at 950°C and with an initial average grain diameter of $\times 55$ μ was cold-rolled to reductions of 10, 20, 40, and 60% at 25, 500, and 700°C. The metal was then heat-treated for 10, 30, 60, 100, 1000, and 10,000 min at individual temperatures of 700, 800, 850, 900, and 1000°C. The recovery and recrystallization behavior of the metal was evaluated through hardness measurements, X-ray line-broadening, and metallography. Author (NSA)

N68-34623# Johns Hopkins Univ., Baltimore, Md. Dept. of Mechanics.
THE EFFECT OF VELOCITY ON THE DEFORMATION OF MODIFIED CHARPY COPPER SPECIMENS
Carroll E. Mobley, Jr. May 1968 131 p refs
(Contract DA-18-001-AMC-745(X))
(AD-672526)

Using a modified Charpy loading configuration, annealed OFHC copper modified Charpy V-notch specimens were broken with various impact velocities, ranging from 0.00090 to 15384 inches/second. Energy absorption for failure, failure bend angle, and extent of penetration were measured for specimens tested at each velocity station. Both the energy absorption for failure and the final bend angle versus velocity plots depicted three velocity regimes and the presence of two critical velocities. An explanation for the presence of the critical velocities was proposed and documented. Author (TAB)

N68-34628# Boeing Co., Renton, Wash. Commercial Airplane Div.
TERMINAL FRACTURE OF TITANIUM ALLOYS CONTAINING STRESS-CORROSION CRACKS
C. S. Carter May 1968 32 p refs
(D8-19771; AD-672324)

Approximately one hundred precracked notch bend specimens of Ti-8Al-4V and Ti-4Al-3Mo-1V, previously sustain loaded in

3.5% sodium chloride solution have been examined. The conditions for complete separation of the specimens were determined. In general, this occurred when the stress intensity at the border of the extending stress-corrosion crack reached the plane strain fracture toughness Klc. Observed deviations from this behavior were primarily attributed to crack length measurement difficulties. The fatigue precrack in specimens loaded to stress intensity levels below the threshold stress intensity level Klscc was not affected by the environment, i.e., there was no blunting. Author (TAB)

N68-34654# Battelle Memorial Inst., Columbus, Ohio.
FABRICATION OF FULLY DENSE (U, Ta) C ALLOYS BY POWDER-METALLURGY TECHNIQUES
James T. Lowder, Edward O. Speidel, and Donald E. Kizer 11 Jun. 1968 42 p refs
(Contract W-7405-ENG-92)
(BMI-1840) CFSTI: HC $3.00/MF $0.65

Powder-metallurgy techniques were studied to fabricate homogeneous (U, Ta)C alloys of near theoretical density. The procedure developed involved: comminution of UC and TaC to powders with a particle size of less than 10 μ, consolidation of UC and TaC powder mixtures by unidirectional vacuum hot pressing, homogenization of the UC-TaC compacts, comminution of the (U,Ta)C alloy to powder with an average particle size of 20 μ, and consolidation of the (U,Ta)C powder to near theoretical density by unidirectional vacuum hot pressing. Densities greater than 99% of theoretical were obtained by vacuum hot pressing $(U_{0.7}Ta_{0.3})C$ and $(U_{0.5}Ta_{0.5})C$ powders for 15 min at 1800°C and 10,000 psi (703 kg per cm^2) and $(U_{0.3}Ta_{0.7})C$ powders for 15 min at 2000°C and 10,000 psi. The hot hardness of as-hot-pressed $(U_{0.7}Ta_{0.3})C$, $(U_{0.5}Ta_{0.5})C$, and $(U_{0.3}Ta_{0.7})C$ decreased rapidly above 1400°C. The hot hardness of $(U_{0.3}Ta_{0.7})C$ annealed at 2400°C exhibited no sharp decrease at temperatures to 1700°C. Author (NSA)

N68-34714# General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center.
GRAIN BOUNDARY STUDIES OF AUSTENITIC STAINLESS STEELS
J. S. Armijo Sep. 1967 20 p refs
(Contract AT(04-3)-189)
(GEAP-5503; EURAEC-2035) CFSTI: HC $3.00/MF $0.65

The problem of intergranular cracking of austenitic stainless steel fuel cladding (which was free of grain boundary carbides or second phases) in high temperature boiling water reactor environments prompted detailed studies of grain boundaries in austenitic stainless steels. The techniques used included grain boundary microhardness, thermoelectric, and polarization measurements. The grain boundary thermoelectric measurement technique was developed but did not reveal differences between grains and grain boundaries in austenitic stainless steels. The microhardness and polarization experiments did demonstrate differences between grains and grain boundaries. The grain boundaries were sometimes found to be harder than the grains. The grain boundaries yielded markedly different polarization data which were qualitatively in agreement with the observed intergranular corrosion behavior. A model was developed from the grain boundary studies and from corrosion test results which describes the effects of variables on the intergranular corrosion susceptibility of nonsensitized austenitic stainless steels. Author (NSA)

N68-34729# Istituto Sperimentale dei Metalli Leggeri, Novara (Italy).
DISPERSION STRENGTHENED ALUMINUM FOR NUCLEAR PURPOSES, WITH PARTICULAR EMPHASIS ON CORRELATION BETWEEN CREEP STRENGTH AND MICROSTRUCTURE PARAMETERS
D. Gualandi, D. Gelli, P. Jehenson (Euratom), L. Mori, and M. Paganelli Brussels EURATOM 1968 28 p refs Presented at the Intern. Conf. on the Strength of Metals and Alloys, Tokyo, 4–8 Sep. 1967
(Contract EURATOM-065-64-7 TEOI)
(EUR-4035.e)

The mechanical properties of dispersion hardened aluminum–aluminum oxide composite materials were studied with emphasis on the correlation between creep strength and microstructure parameters. Experimental data on various aluminum–aluminum oxide compositions established a high correlation between mechanical strength at elevated temperatures and a very reduced grain size. Microcracks in the structure and reduced strength of grain boundaries led to rupture at very reduced elongation under stress conditions. Transformation of the dispersed phase from Al_2O_3 to a mixed oxide ($MgO + MgOAl_2O_3$) increased creep ductility markedly when the specimen life did not exceed 500 hrs. G.G.

N68-34732# Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant.
CRYSTALLIZATION AND PURIFICATION OF BORON METAL POWDER
P. E. Trent 8 Jul. 1968 62 p
(Contract W-7405-ENG-26)
(Y-1614) CFSTI: HC $3.00/MF $0.65

Two methods were found that can be used to transform impure, low-density amorphous boron to a higher-purity, higher-density crystalline boron metal powder. Amorphous boron metal powder was placed in HBR-grade boron nitride containers and heated to 2000° to 2150°C in an inert-atmosphere tungsten suscepted furnace. In the second method, the boron metal powder was passed through a sheath-stabilized helium plasma flame onto a water-cooled target to produce an essentially massive body. Amorphous normal boron produced by reduction of the oxide (B_2O_3) by magnesium metal was crystallized and purified to greater than 99 wt % boron by both of these methods. Electrolytic-cell-produced amorphous boron-10 metal powder was crystallized and purified to greater than 97 wt % boron by both of these methods. Author (NSA)

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N68-33610 National Lending Library for Science and Technology, Boston Spa (England).
THE TESTING OF GLASS FIBRE REINFORCED PLASTIC PLATES
G. Niederstadt and W. H. Boehm [1968] 7 p Transl. into ENGLISH from Kunststoff-Rundschau (Hamburg), v. 18, 1967 p 465–468
(M-7350) Available from Natl. Lending Library, Boston Spa, Engl.

The mechanical properties of glass reinforced plastics consist of a number of properties which depend upon direction and collectively describe the behavior of the material. These properties which depend upon direction must be separately determined in a uniaxial field of stresses. With the aid of two examples it is shown that errors are involved for example in the measurement of E modulus of very wide plates for the evaluation of reinforcement between two clamping points. Such measurements give higher apparent E modulus, especially for directions other than the main direction. When the apparent values are plotted in a polar elasticity diagram the apparent elasticity behavior becomes similar to that of an isotropic medium. Author

N68-33614 National Lending Library for Science and Technology, Boston Spa (England).
X-RAY DIFFRACTION INVESTIGATION OF CHRYSOTILE ASBESTOS
G. A. Kovalev Jan. 1968 12 p refs Transl. into ENGLISH from Zap. Vses. Mineralog. Obshchestva (Moscow), v. 95, no. 1, 1966 p 70–75
(RTS-4304) Available from Natl. Lending Library, Boston Spa, Engl.: 12s 6d

X-ray powder methods and crystal rotation techniques were used to study physico-mechanical properties of chrysotile asbestos of normal strength, brittle chrysotile asbestos, chrysotile serpophites possessing fibrous and massive structures, and rock forming chryostiles made up of essentially chrysotile serpentinites. Objectives of the study were to demonstrate the nonvalidity of previously reported studies which indicated that: (1) the Debye powder method cannot be used to distinguish between asbestoses with different physico-mechanical properties (brittle, and elastic materials); (2) that Debye diagrams of both types of asbestos are identical; (3) that characteristic features the primary factor determining the physico-mechanical properties of asbestos is not the crystal structure, but the texture, i.e., the nature of the packing of the elementary fibrils, and degree of perfection of the orientation relative to a single axis (axial texture). Results indicate that: (1) features of brittle specimen are determined not by texture but by their crystal structure; (2) Debye diagrams for both brittle and elastic types of chrysotile asbestos are not identical since the pattern for elastic-type chrysotile contained no reflections from the reflection planes 130, 201-202, and 204; and (3) the Debye powder method is an accurate method for structural studies of asbestoses with different physico-mechanical properties. S.C.W.

N68-33615 National Lending Library for Science and Technology, Boston Spa (England).
MANUFACTURE, TESTING AND CALCULATION OF COMPOSITE CONSTRUCTIONS OF GLASS FIBRE REINFORCED PLASTICS AND THERMOPLASTICS
G. Menges, P. Schmidt, and F. Vollmer [1968] 12 p refs Transl. into ENGLISH from Plastverarbeiter (Speyer), v. 18, 1967 p 687–692
(M-7352) Available from Natl. Lending Library, Boston Spa, Engl.

Described are manufacturing methods used in the production of reliable PVC-glass reinforced plastic composites and composites of glass reinforced plastics (polyolefines); and methods used to test adhesion properties of the two composites before and after selective treatment. S.C.W.

N68-33652 Lehigh Univ., Bethlehem, Pa.
MECHANISMS OF DENSIFICATION, DEFORMATION AND STRENGTHENING IN ALLOYED, THERMOMECHANICALLY WORKED MAGNESIUM OXIDE
Lyder Attaraas (Ph.D. Thesis) 1967 162 p
Available from Univ. Microfilms: HC $7.60/Microfilm $3.00 Order No. 67-14927

It has been attempted to relate the strength of pressure sintered (and press forged), alloyed magnesia to the processing history, since the mechanisms of densification and deformation have a direct influence on the mechanisms of strengthening. Besides commercially pure MgO, six MgO-alloys were investigated. The alloying compounds were NiO, MnO, Al_2O_3, TiO_2 and nickel metal. The most successful alloys contained either a trace of nickel or one mol% TiO_2 which made the magnesia nonstoichiometric at high temperatures. The nonstroichiometry enhanced the rate of final densification and the rate of press forging, while the room temperature strengths were higher than those of commercially pure magnesia. Densification of oxides during pressure sintering is discussed. Previously proposed densification mechanisms are briefly reviewed, and an attempt is made to outline a new approach toward a more unified picture of the phenomena involved during densification. Dissert. Abstr.

N68-33857 Aeronautical Research Inst. of Sweden, Stockholm.
FATIGUE TESTS AT ROOM TEMPERATURE AND 100° C ONJOINTS BONDED WITH "FM-1000" [UTMATTNING-SPROV PA LIMFOERBAND MED LIM FM 1000 VID RUMSTEMPERATUR OCH 100°C]
[1968] 15 p refs In SWEDISH; ENGLISH summary
(HU-1098) CFSTI: $3.00

Fatigue tests were carried out on bonded joints at room temperature and 100° C, to determine the fatigue properties of American Cyanamid-Bloomingdale "FM-1000". This adhesive is of the polyamide-epoxy type with no reinforcing fabric and has high shear strength at room temperature and relatively good strength at 100° C. The tests have been conducted on single-lap joints in 2024S-T Alclad with an overlap length of 15 mm and a width of 50 mm. The sheet thickness was 2.5 mm. The specimens were loaded in pulsating tension and the lower limit was held constant, corresponding to a shear stress in the joint of 0.1 kg/mm^2. The loading frequency was about 200 cycles/minute for lives less than 10^4 cycles and 2000 cycles/minute for longer lives. The static ultimate shear strength was as on an average 4.3 kg/mm^2 at room temperature and 2.2 kg/mm^2 at 100° C. The endurance limit for a pulsating shear stress with the lower stress limit equal to zero and for a life, N, of 10^7 cycles was about 1.0 kg/mm^2 at room temperature and about 0.6 kg/mm^2 at 100°C. Author

N68-33901 Akron Univ., Ohio.
OZONE CRACKING OF RUBBERS
Hiroshi Hirakawa (Ph.D. Thesis) 1967 171 p
Available from Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-13147

The rates of growth of single cracks in an atmosphere of ozonized oxygen were measured for vulcanizates of butyl rubber at temperatures from 20 to 160°C at 5 mg/l of ozone concentration, ozone concentration up to 7.5 mg/l, an initial tearing energy range from 100 to 5000 $ergs/cm^2$; and variations in unsaturation from 1 to 4.3 mol %. The rates in butyl rubber swollen by Nujol and a styrene-butadiene copolymer (50 w) swollen by Circosol were also measured over a temperature range from −6° to 95°C and an ozone concentration range up to 6 mg/l. Rates in rubbers containing the antiozonant (EDTQ) (about 1-2 wt %) were measured. A partially-hydrogenated polyisoprene containing 33 mol % unsaturation was crosslinked by 1.8 parts of DICUP. Measurements were made of volume expansion, flow times of ozonized solutions, intrinsic viscosity of ozonized solutions, molecular weight between crosslinks and logarithmic decrement. Polyisoprene partially-hydrogenated by Ni-catalyst contained block type of saturated units. Dissert. Abstr.

N68-33978 Princeton Univ., N. J. Frick Chemical Lab.
LABILE CROSSLINKS IN LOW UNSATURATION ELASTOMERS, 2. EFFECT OF CHAIN AND CROSSLINK STRUCTURE ON THERMAL AND OXIDATIVE STABILITY
Peter F. Lyons, Timothy C. P. Lee, and Arthur V. Tobolsky Apr. 1968 35 p refs
(Contract N00014-67-A-0151-0011)
(ONR-TR-RLT-106; AD-669497)

The thermal and oxidative stability of low unsaturation elastomers was studied as a function of chain and crosslink structure by stress relaxation and oxygen absorption techniques. An ethylene-propylene-terpolymer, a propylene oxide copolymer, and an ethylene sulfide-propylene sulfide-terpolymer were used. The thermally labile polysulfide crosslink that results from sulfur cures is a potent antioxidant. The thermal lability is ascribed to an interchange mechanism, with an activation energy of 24 kcal/mole between 100 and 150C. The presence of an atom of oxygen in

the chain results in an increased susceptibility to oxidative degradation compared with a hydrocarbon chain. The presence of a sulfur atom in the polymer chain confers a sensitivity to a destructive attack by the active ingredients and products of an accelerated sulfur curing recipe. Author (TAB)

N68-33982# Purdue Univ., Lafayette, Ind. School of Aeronautics, Astronautics and Engineering Sciences.

EXPERIMENTAL INVESTIGATION OF NONLINEAR, NON-ISOTHERMAL VISCOELASTICITY

Charles W. Mc Guirt and George Lianis Jan. 1968 62 p refs

(Grant NSF GK-413)

(AA&ES-68-2)

The viscoelastic behavior of styrene–butadiene rubber (SBR) under finite uniaxial and equal biaxial deformations is investigated for the non-isothermal case. It is found that the material is thermorheologically simple in that variable temperature fields can be accounted for through the so-called time–temperature superposition principle familiar to infinitesimal viscoelasticity. Constitutive equations on the same form as in isothermal viscoelasticity are used with real time replaced by reduced time. The material properties of SBR are evaluated from stress relaxation data throughout the range 30° C to 27° C. The shift factor is evaluated and master curves for the material properties are plotted in terms of reduced time. Theoretical expressions are evaluated for the stress in several combined deformation and variable temperature histories. The histories chosen are the uniaxial single-step, the equal biaxial single-step, and the uniaxial constant stretch rate loading. The temperature varied approximately 45° C for each case. Theoretical and experimental results are compared. Author

N68-34247*# California Inst. of Tech., Pasadena. Firestone Flight Sciences Lab.

ON THE NUMERICAL DETERMINATION OF RELAXATION AND RETARDATION SPECTRA FOR LINEARLY VISCOELASTIC MATERIALS

Wolfgang G. Knauss and John F. Clauser Aug. 1967 19 p refs Presented at the 38th Meeting of the Soc. of Rheol., Washington, D. C., 23–25 Oct. 1967 Submitted for publication

(Grant NsG-172; Contract AF 04(611)-9572)

(NASA-CR-88252; GALCIT-SM-67-6; GALCIT-120) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Numerical solutions of the definitive singular Fredholm integral equation were examined. A solution based on Simpson quadrature leads to an unstable solution in the sense that an increase in integration intervals produces a progressively worse solution which oscillates between positive and negative values. This difficulty may be overcome by requiring that the curvature of the relaxation spectrum with respect to the relaxation times be minimized. The method is tested on the modified power law. Good agreement with the exact and numerically determined relaxation spectrum is obtained. However, when the same method is used to determine the retardation spectrum, only the unstable solution is obtained, although the form of the integral equation is the same. This difference behavior is attributed to the difference in the characteristics of the relaxation and retardation spectral functions. Author

N68-34260# Royal Aircraft Establishment, Farnborough (England).

THE PREDICTION OF SHELF-STORAGE LIFE IN RUBBERS FROM ACCELERATED HEAT AGEING TESTS. PART 2: STRESS-RELAXATION TESTS

D. K. Thomas and B. B. Moore Jan. 1968 13 p refs

(RAE-TR-68016, Pt. 2) CFSTI: HC $3.00/MF $0.65

It is possible to extrapolate the results of intermittent stress-relaxation experiments at elevated temperatures to room temperature and, in so doing, to describe the rate of change of rubbery modulus with time at that temperature. Good correlations are found between changes predicted in this way and those observed in shelf-storage experiments. Although stress-relaxation studies can be laborious and therefore unsuitable for routine testing, their close correlation with shelf-storage results and accelerated oven ageing tests increases confidence in the results of the latter. Author (ESRO)

N68-34284*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC OXIDATION AND COMPATIBILITY OF BORON NITRIDE AND BORON NITRIDE COMPOSITE TO 2000°C

John D. Buckley Apr. 1968 27 p refs Presented at the 70th Ann. Meeting of the Am. Ceram. Soc., Chicago, 20–25 Apr. 1968

(NASA-TM-X-61233) CFSTI: HC $3.00/MF $0.65 CSCL 11B

Two grades of boron nitride and a boron nitride composite were subjected to temperatures up to 1500°C in air and up to 2000°C in a vacuum of 10^{-5} torr for various periods of time. Compatibility tests were made with four refractory oxides, JTA graphite composite, and five refractory metals at temperatures up to 1800°C. The results showed that composition influences thermal shock and oxidation resistance of boron nitride bodies. Little or no reaction occurred between the boron nitride compositions and the refractory ceramics at temperatures up to 1500°C and the refractory metals at temperatures up to 1000°C. Author

N68-34299*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MECHANICAL PROPERTIES OF POLYMIDE-RESIN/GLASS-FIBER LAMINATES FOR VARIOUS TIME, TEMPERATURE, AND PRESSURE EXPOSURES

Richard A. Pride, Bland A. Stein, and Ferdinand W. Schmidt Feb. 1968 32 p refs Presented at the Soc. of the Plastic Ind. (SPI) 23rd Ann. Reinforced Plastics Tech. and Management Conf., Washington, D. C., 6–9 Feb. 1968

(NASA-TM-X-61212) CFSTI: HC $3.00/MF $0.65 CSCL 11I

An experimental investigation has been conducted to study the behavior of a polyimide-resin/glass-fiber laminate over a range of temperatures from −320°F to 1050°F. In addition, the behavior was studied before and after various exposures to temperatures from 450°F to 800°F and pressures of 760, 35 and 10^{-6} torr. Mechanical properties in flexure and shear were determined by 3-point bending tests on more than 1100 small laminated beam specimens. A general trend of decreasing strength with increasing temperature, exposure time and pressure is observed; however, results indicate that good bonding was developed in the polyimide-resin/glass-fiber system in spite of a 24% void content of the laminate. Exposure times of 10,000 hours have been completed. Low pressure exposures support the postulation of a degradation mechanism based on oxidation of the polyimide resin. The effect of exposure on certain properties of laminated beams shows good correlation with the effect of similar exposures on selected properties of honeycomb sandwiches. Author

N68-34374# Army Natick Labs., Mass. Clothing and Organic Materials Lab.

THERMAL DEGRADATION OF POLYVINYLIDENE FLUORIDE AND POLYVINYL FLUORIDE BY OVEN PYROLYSIS

John T. Stapler, William J. Barnes, and William E. C. Yelland Jul. 1968 50 p refs

(C/OM-50; TR-69-7-CM; AD-672509)

The military has a definite and pressing need to develop materials to protect personnel and equipment against the thermal effects of a nuclear weapon detonation. The thermal behavior of polymers which appear to have capabilities for attenuating such energy is therefore of interest. The report presents the results of a study made on the thermal degradation products obtained from the two fluoropolymers, polyvinylidene fluoride and polyvinyl fluoride, by oven pyrolysis. It describes the separation of the thermal degradation products of the polymers into fractions, and reports the

elemental analyses of these fractions, and the identification of as many constituents of these fractions as was feasible. TAB

N68-34378# Los Alamos Scientific Lab., N. Mex.
POLYCARBONATE AS AN ADHESIVE
S. E. Newfield and E. P. Ehart 5 Jun. 1968 6 p ref
(Contract W-7405-ENG-36)
(LA-3890) CFSTI: HC $3.00/MF $0.65

Injection-molding grade clear polycarbonate resin has been used as a hot-melt adhesive in several experimental bonding applications. The low creep, non-outgassing, and favorable heat-deformation properties of this resin, linked with its newly discovered adhesive properties, make polycarbonate an ideal adhesive in certain applications. Author (NSA)

N68-34410# Picatinny Arsenal, Dover, N. J. Plastics Technical Evaluation Center.
THE WEATHERABILITY OF POLYOLEFINS
Joan B. Titus Mar. 1968 100 p refs
(PLASTEC-32; AD-672513)

The report covers the effects of the weathering components on polyolefins; exposure testing methods; means of stabilization and the effects of pigments. In addition, a few examples of successful polyolefin outdoor applications are given. TAB

N68-34464# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AN INVESTIGATION OF THE PHYSIOCHEMICAL NATURE OF METAL-LIKE AND NONMETALLIC HIGH-MELTING COMPOUNDS BY THE MICROHARDNESS METHOD [ISSLEDOVANIE FIZIKOKHIMICHESKOI PRIRODY METALLOPODOVNYKH I NEMETALLICHESKIKH TUGOPLAVKIKH SOEDINENII METODOM MIKROTVERDOSTI]
G. V. Samsonov Sep. 1967 24 p refs Transl. into ENGLISH from Sovesch. Po Mikrotverdosti (Moscow), no. 2, 1963 p 59–71
(FTD-HT-67-269; AD-672340)

This review of microhardness is concerned with metalloid and nonmetallic refractory compounds. The author attempts to show that microhardness depends mainly on two factors: electron density and crystal structure. The microhardness of a number of transition metals, carbides, nitrides, borides, and silicides is compared in terms of the electron-accepting ability of the d-orbitals = 1/Nn, where n is the number of electrons in the incompleted d-orbital and N the principal quantum number of the d-orbital. It is noted that microhardness increases with increase in (1/Nn) and with the degree of symmetry of the electron distribution. For nonmetallic compounds, the microhardness depends on the nature of the p-function and decreases with increase in the principal quantum number of the p-electrons. TAB

N68-34570# Picatinny Arsenal, Dover, N. J. Plastics Technical Evaluation Center.
SUBJECT INDEX, BIBLIOGRAPHY, AND CODE DESCRIPTION OF TECHNICAL CONFERENCE PAPERS ON PLASTICS: 19 MAY 1967–10 MAY 1968
Joan B. Titus and Arnold E. Molzon Aug. 1968 176 p refs
(PLASTEC-35)

The papers presented at technical conferences on plastic materials and related technology from 19 May 1967 to 10 May 1968 (which were available to Plastec) have been listed, indexed by subject, material, type of data and author. Over 700 papers from 21 conferences were included. Author

N68-34620# Army Mobility Equipment Command, Fort Belvoir, Va.
EVALUATION OF THE LOW-TEMPERATURE PROPERTIES OF INHERENTLY OZONE-RESISTANT ELASTOMERS Interim Report, May 1964–Dec. 1967
Paul E. Gatza and Paul Touchet Jun. 1968 26 p
(USAMEC-1929; AD-672042)

The report covers an evaluation of the potential for end-item applications of several elastomers purported to be both inherently ozone resistant and serviceable at temperatures as low as -65F. Using specification requirements detailed in Specifications MIL-I-3930C and MIL-R-14328A as guidelines, results of physical testing and compound development studies on ethylene-propylene, modified butyl, and propylene oxide elastomers are compared with results obtained on a compound of SB-R 1023. Although the latter is not an inherently ozone-resistant rubber, it is acceptable for use at -65F. Other physical characteristics such as heat, oxygen, water and weather resistance, deemed essential for satisfactory performance in general-purpose applications, were determined for these elastomers and are analyzed and discussed. Author (TAB)

N68-34632# Royal Aircraft Establishment, Farnborough (England).
STUDIES ON CARBONIZATION OF POLYACRYLONITRILE FIBRE. PART 2: CHANGES IN MOISTURE SORPTION AND STRUCTURE WITH HEAT TREATMENT
Kazuo Miyamichi and Masamichi Jun. 1968 11 p refs Transl. into ENGLISH from Sen-i Gakkaishi (Tokyo), v. 21, no. 12, 1965 p 640–643
(RAE-LIB-TRANS-1307) CFSTI: HC $3.00/MF $0.65

The influence of heat treatment in nitrogen to temperatures in the range 300° to 1000° C on the composition and hygroscopicity of flame proofed polyacrylonitrile fibres was studied, the fibres having been flame proofed by an oxidation pretreatment. The flameproofing treatment produced a large number of hydrophilic functional groups, a limited amount of crosslinking, a coarse structure and a reduction in mechanical properties. Heat treatment in nitrogen at temperatures up to 500° C increased the crosslinking and densified the surface structure which resulted in a lowering of the elongation to fracture and an increase in Young's modulus and abrasion resistance. There was not much change in composition below 500° C apart from dehydrogenation. Capillaries formed and the carbon content increased at temperatures above 500° C. During this carbonization stage there was an increase in the number of condensed carbon rings and a strengthening of the fibres. It appeared that the density of crosslinking had reached saturation point at 500° C as the decrease in elongation to fracture after higher heat treatment temperatures was negligible. The results indicated that the carbon structure was approximately formed at 900° C although it was still irregular. Author

N68-34664# National Bureau of Standards, Washington, D. C. Metallurgy Div.
RESEARCH ON HIGH TEMPERATURE MATERIALS AT THE NATIONAL BUREAU OF STANDARDS
Elio Passaglia Jul. 1968 23 p
(NBS-TN-447; AD-672076)

The National Bureau of Standards, with support from the Advanced Research Projects Agency of the Department of Defense, has begun a program on High Temperature Materials. This program includes projects on properties of high temperature materials, projects on their preparation, and others designed to explain basic phenomena limiting the use of materials at high temperatures. A summary of the progress in this program is given. Author (TAB)

N68-34667*# Florida State Univ., Tallahassee.
[STUDY OF CRYSTALIZATION, CROSSLINKING AND DIMENSIONAL CHANGES DURING THE CRYSTAL-LIQUID PHASE TRANSITION OF ORIENTED POLYMERIC SYSTEMS] Semiannual Report for Period Ending 1 Sep. 1968
Leo Mandelkern 1 Sep. 1968 7 p
(Grant NsG-247-62)
(NASA-CR-96723) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Radiochemical reactions in the crosslinking of polymers by high energy radiation and the dependence of crosslink efficiency and network properties on the state of the system when the crosslinks are introduced were investigated. Molecular weight fractions of linear polyethylene were crystallized under controlled conditions and irradiated as a function of temperature and state. Data were obtained on hydrogen evolution, vinyl disappearance, and the formation of *trans* unsaturation; vinyl-end group involvement in the crosslinking and gelation processes was found. Morphological studies of crystalline polyethylene are being continued with major emphasis on the density and enthalpy of fusion of crystals formed from dilute solution. M.W.R.

N68-34677# Michigan Univ., Ann Arbor. Inst. of Science and Technology.
STRENGTH-STRUCTURE RELATIONSHIPS IN VITREOUS INFRARED MATERIALS. Final Report, 1 Apr. 1967–31 Mar. 1968
W. C. Levengood and T. S. Vong Jul. 1968 27 p refs
(Contract Nonr-1224(57); ARPA Order 269)
(Rept.-7518-13-F; AD-672186)

Investigation of basic strength and structure relationships in vitreous materials revealed that a linear relationship existed between the inherent breaking strength and the microelasticity of the three glass systems which were examined, silicates, calcium aluminates, and arsenic trisulfides. Using this relationship, it is possible to explain the wide spread observed in breaking-strength data in terms of microelasticity variability and to utilize these linear curves to analyze subtle alterations in the basic structure and in the surface conditions of glasses. Regular polishing techniques as well as surface abrasion and mechanical damage produced quite drastic changes in the microelasticity characteristics of the glasses. The effect of melting conditions was examined in arsenic trisulfides, and data are presented showing an increase in strength after a melting treatment designed to reduce optical absorption bands in the material. The importance of surface polishing in altering microelasticity characteristics was corroborated in the studies with arsenic trisulfides. Irtran materials were also examined. Irtran type no. 1 disclosed a structure more characteristic of a vitreous material than of a polycrystalline, which indicates that under certain conditions the hot press type of network may approach some degree of amorphism. Data concerning the relationship between shear modulus values determined by sound-velocity measurements and the flaw parameters in the three basic systems are also presented. Author (TAB)

N68-34704# National Bureau of Standards, Washington, D. C. Building Research Div.
ORGANIC COATINGS: PROPERTIES, SELECTION, AND USE
Aaron Gene Roberts Feb. 1968 204 p refs *Its* Bldg. Sci. Ser. No. 7
(NBS-BSS-7) GPO: $3.00

This publication was prepared to fill the need for a comprehensive, unifying treatise in the field of organic coatings. Besides presenting practical information on the properties, selection, and use of organic coatings (and certain inorganic coatings), it provides basic principles in a number of important areas such as polymer structure, coatings formulation, pigment function, use of thinners, coating system compatibility, and theory of corrosion. Each chapter deals with a major area of the coatings field including types of coatings, properties of synthetic resins, selection of coating systems, storage and safety, application methods, and surface preparation and pretreatment. There is also a consolidating chapter with illustrative examples of solutions to typical coating problems. Author (USGRDR)

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N68-33623 California Inst. of Tech., Pasadena.
STABILITY OF PARAMETRICALLY EXCITED DIFFERENTIAL EQUATIONS
John Randall Dickerson (Ph.D. Thesis) 1967 84 p
Available from Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-14364

Stability requirements are presented in terms of the modulus of (1) the amplitude of the parametric terms, (2) the integral of the parametric terms and (3) the derivative of the parametric terms. The methods employed to show stability are Liapunov's direct method and the Gronwall lemma. The type of stability is generally referred to as asymptotic stability in the sense of Liapunov. The results indicate that if the equation of the system with the parametric terms set equal to zero exhibits stability and possesses bounded operators, then the system will be stable under sufficiently small modulus of the parametric terms or sufficiently small modulus of the integral of the parametric terms (high frequency). On the other hand, if the equation of the system exhibits individual stability for all values that the parameter assumes in the time interval, then the actual system will be stable under sufficiently small modulus of the derivative of the parametric terms (slowly varying). Dissert. Abstr.

N68-33679 Lehigh Univ., Bethlehem, Pa.
ISOMETRIES OF COMPACT SUBMANIFOLDS OF A RIEMANNIAN MANIFOLD
Burgess Harold Rhodes (Ph.D. Thesis) 1967 36 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-14949

Let M be a differentiable manifold of dimension $n \geq 2$, $x,x^*: M \to R$ two immersed compact submanifolds in a Riemannian manifold R of dimension $n+m$ ($m>0$) admitting an infinitesimal nonisometric conformal transformation Ξ, and $f: x(M) \to x^*(M)$ a volume-preserving diffeomorphism. Conditions are found for (1) f to be an isometry and (2) hypersurfaces x(M), x^*(M) to have the same second fundamental form when $m=1$. In particular, when R is a Euclidean space E, these conditions were obtained by Chern and Hsiung for case (1), and by Hsiung for case (2), as in these cases, in E the position vector of a point with respect to a fixed point 0 generates an infinitesimal nonisometric homothetic transformation. Dissert. Abstr.

N68-33691 Rice Univ., Houston, Tex.
SEMIGROUP MARTINGALES
Glenn Allen Stoops (Ph.D. Thesis) 1967 41 p
Available from Univ. Microfilms: HC $3.00 Microfilm $3.00 Order No. 67-13128

This paper discusses linear operators from the Banach space of continuous functions, complex or real, to the dual space of Radon measures. The basic continuity assumption on such operators is that they map weak convergent sequences to strongly convergent sequences. It is shown that this condition is equivalent to the representation of an operator as an integral operator with continuous kernel. Under an additional symmetry hypothesis the restriction of the operator has a second representation in terms of an eigenfunction expansion. The motivating example of a martingale, which this paper extends, is that given by the Poisson integral operator in the theory of harmonic functions. This example is studied in some detail in order to illustrate some of the results that have been obtained. Dissert. Abstr.

N68-33692 Texas Univ., Austin.
HOLES IN TWO-DIMENSIONAL SPACE
Joel Leslie O'Connor (Ph.D. Thesis) 1967 58 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-14872

Hole is defined in a space in which there exists a meaning having certain properties for interior and exterior of a simple closed curve. Two theorems of Janiszewski are generalized by replacing a condition of compactness with a condition on holes and by distinguishing between connected and connectible. Descriptions in terms of holes are given for a region contained in an arc, a cutpoint of a connected domain, an endpoint of space, and a non-accessible boundary point. Dissert. Abstr.

N68-33694 Polytechnic Inst. of Brooklyn, N. Y.
GEOMETRY OF BANACH ALGEBRAS
Ian Nelson Spatz (Ph.D. Thesis) 1967 39 p refs
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-13422

Various geometric properties of the unit sphere of a Banach algebra with identity of norm one are studied in this dissertation. These properties are smoothness, rotundity, local uniform convexity, and uniform rotundity. Dissert. Abstr.

N68-33702 IIT Research Inst., Chicago, Ill.
ON THE STATICAL METHOD OF MINIMAL DESIGN FOUNDATIONS AND APPLICATIONS
Robert Reiss (Ph.D. Thesis) 1967 90 p
Available from Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 67-14564

Variational calculus is used to extend the statical method of minimal design for nonlinear volume functionals. The Euler equation is shown to be equivalent to the constant energy dissipation condition; sufficiency and uniqueness conditions are obtained. For cases in which absolute minima do not exist, a method is developed to obtain a sequence of designs whose volumes converge to the greatest lower bound of the functional. In particular, this procedure shows that for an axisymmetric solid plate a sequence of safe designs, with corresponding volumes approaching zero, can be found. Absolute minima of volume and sequences of solutions converging to the greatest lower bound of the volume functional are obtained for several cases of circular plates and cylindrical shells of sandwich construction under axisymmetric loading. Dissert. Abstr.

N68-33706 Polytechnic Inst. of Brooklyn, N. Y.
WIENER–HOPF TECHNIQUES AND SINGULAR INTEGRAL EQUATIONS
Gerald Jack Bierman (Ph.D. Thesis) 1967 76 p
Available from Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-13380

In this paper, we consider equations of the form $\int_0^b K(x-t)\,f(t)dt = h(x)$, $x>0$, $b>0$ where b may be infinite, and K(x) is allowed simple poles on the interval [0,b]. The case $b=\infty$ is considered in detail, and representations for the solution are obtained by applying Wiener–Hopf type arguments. Wiener–Hopf decompositions for meromorphic functions are investigated. Formulas are derived which give the order of algebraic growth of the decomposition functions in terms of the zeros and poles of the function in its fundamental strip of holomorphy. Dissert. Abstr.

N68-33707 Boston Univ., Mass.
ON THE GEOMETRY OF A PREHILBERT MANIFOLD OF CURVES AND MINIMAL SURFACES
Antonio Gervasio Colares (Ph.D. Thesis) 1967 80 p
Available from Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-13298

The set D(M) of differentiable curves in a finite dimensional Riemannian manifold M is made into an infinite dimensional prehilbert manifold by a method of J. Eells, Jr. Functions, curves and vector fields on d(M) are related to corresponding geometric objects in M, including the proof of a lemma relating differentiability of vector fields on D(M) and M. Existence and uniqueness of integral curves of certain vector fields on the tangent bundle to D(M) is proved. It is demonstrated that to each spray (torsionless connection) over M corresponds a spray (torsionless connection) over D(M) in such a way that the correspondence spray-torsionless connection is preserved. Moreover, the connection over D(M) corresponding to the Riemannian connection over M is the Riemannian connection over D(M) if M is flat. For general M, the Riemannian connection over D(M) is obtained from the Riemannian connection over M perturbed by a certain vector field. Dissert. Abstr.

N68-33708 Alabama Univ., University.
APPLICATIONS OF LINEAR PROGRAMMING IN CHEBYSHEV APPROXIMATIONS
Fred Davis (Ph.D. Thesis) 1967 59 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-13235

This paper accomplishes the following results: (1) Linear programming is introduced nontrivially into the study of the discrete Chebyshev approximation problem formulated by Loeb. (2) Certain new theorems are developed to characterize the solutions of Loeb's formulation. (3) A new algorithm is stated for use in the iterative process required in Loeb's formulation. (4) A new formulation of the Chebyshev problem is made which significantly reduces the hypotheses and the computational problem of the Loeb formulation. (5) Theorems are developed which establish the validity of a proposed iterative solution scheme for the new formulation. (6) Theorems are developed to characterize the solutions of the new formulation. (7) Loeb's linear inequality algorithm is modified to apply to the new formulation. Dissert. Abstr.

N68-33709 Lehigh Univ., Bethlehem, Pa.
NORMING SUBSPACES, TOEPLITZ BASES, AND THEIR RELATIONSHIPS
Donald R. Kerr, Jr. (Ph.D. Thesis) 1967 87 p
Available from Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 67-14940

The norming subspaces of the dual of a Banach space are characterized and the characteristics of maximal norming subspaces of c_0^* and c^* are computed. By relating some work of Fleming, McWilliams and Retherford to this thesis it is established that l is depressed and hence that a non-depressed Banach space with unconditional basis is reflexive. It is shown that the dual of each non-complete normed space has a maximal subspace which is depressing. The generalization of Schauder basis to Toeplitz basis which was introduced by Gelbaum and Kozlov is investigated. Several results are established for the Toeplitz basis which are well known for the Schauder basis. Dissert. Abstr.

N68-33752 Cornell Univ., Ithaca, N. Y.
CRITERIA FOR APPROXIMATE SOLUTIONS OF LINEAR TIME-VARYING DIFFERENTIAL SYSTEMS
Hugh Foch Van Landingham (Ph.D. Thesis) 1967 180 p
Available from Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-16376

An approach is presented for the analysis of linear systems by finding acceptable approximate system behavior. Three main classes of forced linear systems are delineated with respect to types of parameter variation. With an effort toward retaining the original model structure, approximations are defined and a quantitative framework is outlined for calculating uniform error bounds between the exact and the approximate solutions. Special emphasis is placed

on quantifying the intuitively palatable notation of slowly-varying, or adiabatically invariant systems. Uniform error bounds between the exact and approximate solutions are derived for first-order systems with arbitrary periodic forcing terms. The results are then extended to cover higher order systems with periodic forcing terms via state-space characterization. Finally, the ideas are considered in a more abstract setting, thereby generating whole classes of equivalent systems which satisfy the approximation to within a given uniform error tolerance. Dissert. Abstr.

N68-33776 Pennsylvania Univ., Philadelphia.
CRITICAL POINTS OF THE STATE VECTOR MAGNITUDE
George Charles Reis (Ph.D. Thesis) 1967 91 p
Available from Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-12797

In this dissertation interest is centered on the zero-input response of a linear, time-invariant, differential system whose state equations have the form $\dot{x}(t) = A\,x(t)$ where $x(t)$ is an n-vector and A is a matrix of real numbers. Let the magnitude of the state vector be denoted by m, and its time derivative by $\dot{m}$. Then $m = m(x)$ and $\dot{m} = (x, A)$. A particular x will be a critical point if $\dot{m}(x, A) = 0$. The collection of all critical points is denoted by Z. In similar fashion we define the sets P and N as the collection of points for which $\dot{m} > 0$ and $\dot{m} < 0$, respectively. It is first shown that Z is empty if and only if the matrix A is definite, and that both P and N are not empty if and only if A is indefinite. A simple set of necessary and sufficient conditions for the indefiniteness of A is developed. As a consequence of this, it is shown that almost all systems in phase-variable form are indefinite and that normal, indefinite, real matrices are unstable. Dissert. Abstr.

N68-33844 Purdue Univ., Lafayette, Ind.
HYPERGEOMETRIC SPACES OF ENTIRE FUNCTIONS
Richard Bolstein (Ph.D. Thesis) 1967 45 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-16615

We study the structure of Hilbert spaces of entire functions in which multiplication by z is a closed symmetric transformation of deficiency index (1,1). Examples of such spaces are related to Sonine's theory of self-reciprocal functions for the Hankel transformation. These spaces have many properties in common with known spaces of hypergeometric type (spaces for which a solution of the structure problem can be given in terms of hypergeometric functions). The defining functions A(z) and B(z) for such a space satisfy a recurrence relation. The axiom is hereditary in subspaces. The coefficients of the recurrence relation are solutions of first-order differential equations. We obtain a solution of the structure problem when h = 1 and give an inductive method for solving the problem when h is an integer. The solution is not known for noninteger values of h. Dissert. Abstr.

N68-33847 Texas Univ., Austin.
GROUP THEORY AND THE CLASSICAL KEPLER PROBLEM
Harold Hubert Rogers, Jr. (Ph.D. Thesis) 1967 53 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-14879

A set of finite, canonical transformations which leave the negative energy surfaces of the nonrelativistic Kepler problem invariant is given explicitly. These transformations are most easily obtained by using Fock's method of stereographic projection in momentum space. The momentum transformation is obtained by performing a rotation of the stereographic coordinates on the sphere and then looking at the transformation induced in the momentum space. The resulting transformation is then extended into a canonical transformation. The results are most elegantly presented in the three dimensional case by using quaternions while, for the two dimensional case, ordinary complex numbers are employed. The canonical transformations so obtained have the property of leaving invariant any specified negative energy surface. The two dimensional case is then studied in greater detail. Dissert. Abstr.

N68-33907 Oklahoma Univ., Norman.
OPTIMIZATION PROBLEMS IN BANACH SPACE
Jon Kieth Cole (Ph.D. Thesis) 1967 69 p
Available from Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 67-15911

The Bochner integral is applied to control problems in Banach spaces of varying degrees of generality. The concepts of Bochner p-integrability and strong measurability are discussed, and a norm is defined on the Banach space of Bochner p-integrable functions from a compact interval of the real line to a Banach space. Two Filippov type lemmas are proved, and the weak compactness of certain classes of functions is proved. Weak solutions to the equation of evolution in a separable and reflexive Banach space are considered, and time-optimal solutions to the fixed end-point problem are discussed. Various corollaries concerning the attainable set are obtained. In the penultimate section, a nonlinear process is treated. A time-optimal solution to the problem of a single fixed end-point and an upper semicontinuously varying target set is considered. The compactness of the attainable set is shown. A counterexample and an example are given. Dissert. Abstr.

N68-33929 Pennsylvania Univ., Philadelphia.
AN EXTENSION OF THE DIRECT METHOD OF LYAPUNOV
Hemmige Venkata Rangachar (Ph.D. Thesis) 1967 121 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 No. 67-12795

It was established that, although in general the stability conditions as obtained by the direct method are only sufficient, for a certain class of differential equations, they are both necessary and sufficient. This class is characterized by the following two properties. (1) The inequalities giving the stability conditions for a given equation are mutually exclusive from those giving the stability conditions of the same equation transformed by the negative time transformation $t = -T$. (2) Global asymptotical stability can be established by the direct method. This result was employed to examine the stability of many types of nonlinear equations and many practical examples in the field of control systems. The Lyapunov functions were utilized to define the inner and the outer boundary of the region containing the limit cycle for the Van der Pol's equation, as a function of the damping coefficient ϵ. Dissert. Abstr.

N68-33972 New Mexico State Univ., University Park.
A TAYLOR SERIES SOLUTION OF THE PROBLEM OF CAUCHY
Donald Ray Eager (Ph.D. Thesis) 1967 109 p
Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-11404

The subject is a method for finding solutions of a certain class of partial differential equations which fall under the classification of the problem of Cauchy. The method of attack consists of first assuming the solution in the form of a multivariate Taylor series. In the cases of equations with two or three independent variables, step by step procedures are included which enable solution of the equations without knowledge of the supporting theory. These procedures lend themselves to use on a digital computer. In practice, only a finite number of terms in the series solution will be found. The solutions are consequently approximate. However, any accuracy desired may be achieved by finding a large enough number of terms. Dissert. Abstr.

N68-33989*# General Precision Systems, Inc., Little Falls, N. J. Kearfott Group.
BIRKHOFF NORMALIZATION PROCESS PROGRAM FOR TIME-DEPENDENT HAMILTONIAN SYSTEMS
W. Fine and S. Kass May 1968 74 p refs
(Contracts NAS8-20062; NAS5-9350; AF 49(638)-1466)
(NASA-CR-96634; AFOSR-68-0875; AD-671548) CFSTI: HC $3.00/MF $0.65 CSCL 12A

This is a complete documentation of a computer program for analyzing finite time stability properties of equilibrium points of time-dependent (nonconservative) Hamiltonian systems. Using this package, approximate analytic solutions which contain nonlinear effects can be constructed near these equilibrium points. Qualitative rate-of-growth estimates can also be obtained. This program description is a sequel to AD-647 194 which contained the program description for analyzing time-independent Hamiltonian systems. Author (TAB)

N68-34027* Kent State Univ., Ohio. Mathematics Dept.
MARTINGALE CONVERGENCE AND THE RADON-NIKODYM THEOREM IN BANACH SPACES
S. D. Chatterji May 1967 23 p refs Presented at the Nato Conf. on Probability and Statistics, Greece, Aug. 1966 Submitted for publication Revised
(Grant NsG-568)
(NASA-CR-84701; TR-21) CFSTI: $3.00 CSCL 12A

Proof is offered that the validity of almost any general theorem for martingales with values in a B-space is equivalent to the fact that the Radon–Nikodym theorem is valid for set functions with values in such spaces. This is based on the premise that without some condition on the B-space concerned, several important convergence theorems of the scalar-valued case are invalid. Consideration is given to the case where the underlying measure space is a probability space S, with σ-algebra Σ of measurable subsets, and P a σ-additive positive measure on Σ with P(S) = 1. Author

N68-34094# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
THE ANALOG COMPUTER SOLUTION OF DIFFERENTIAL EQUATIONS OF THE FORM L(D)Y(T) = M(D)U(T)
L. G. Birta Dec. 1967 49 p refs
(NRC-10136; MK-22) CFSTI: HC $3.00/MF $0.65

The analog (or digital) computer solution of a linear differential equation of the form L(D)y(t) = M(D)u(t) is invariably obtained by solving an equivalent set of linear first-order differential equations. It is shown that if the polynomials L(D) and M(D) have a common factor, this equivalent set of first-order equations must be chosen in a particular manner. The initial conditions associated with the equivalent first-order system are intimately related to the given initial conditions on y and its derivatives. The fundamental equation embodying this interrelation is developed. Author

N68-34124# Institut Royal Météorologique de Belgique, Brussels.
ON THE EFFECT AND IDENTIFICATION OF ACCIDENTAL ERROR IN SIMPLE AND SIMULTANEOUS MEASUREMENT SERIES [SUR L'EFFET ET LA RECHERCHE DE L'ERREUR ACCIDENTELLE DANS LES SERIES DE MESURES SIMPLES ET SIMULTANEES]
R. Sneyers *In* WMO Precision of Pyrheliometric Meas. 1967 p 93–102 refs In FRENCH (See N68-34115 21-14)

Statistical theory is applied to random errors in measuring the value of physical phenomenon particularly to the case where series of measurements are made. ESRO

N68-34184# Imperial Coll. of Science and Technology, London (England). Dept. of Mathematics.
THE THEORY OF FUNCTIONS IN COMPLEX ANALYSIS
J. Clunie 7 Jun. 1968 11 p
CFSTI: HC $3.00/MF $0.65

A brief description is given of the theory of functions, assuming that the concepts of complex numbers and functions are known. Cauchy's theorem is reviewed as well as the maximum Modulus Principle. Finally the theory of univalent functions followed by a description of the Area Principle is presented. ESRO

N68-34198# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
STUDY OF THE ASYMPTOTIC EXPANSION OF MULTIPLE INTEGRALS IN MATHEMATICAL PHYSICS [ETUDE SUR LES DEVELOPPEMENTS ASYMPTOTIQUES DES INTEGRALES MULTIPLES DE LA PHYSIQUE MATHEMATIQUE]
Nicholas Chako (Ph.D. Thesis—Paris Univ.) Jan. 1968 88 p refs In FRENCH
(CEA-R-3263) CFSTI: HC $3.00/MF $0.65

The method of stationary phase was applied to evaluate double and multiple integrals of the type $U(k) = \int g(x)\, e^{ik\phi(x)} dx$ where $(x) = (x_1, x_2, \ldots, x_n)$ for large values of the parametre k. The results obtained by the application of the stationary phase method to the integrals (double) of diffraction and the results derived by using the Young–Rubinowicz method are compared. Result of the analysis shows the equivalence of the two methods of approach to the problems of diffraction based, on one hand, on the Fresnel–Kirchoff theory and, on the other hand, the Young–Rubinowicz theory, provided one interprets in a proper manner the results derived from the two methods, especially the expression of the geometrical wave. Author (ESRO)

N68-34282*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
NUMERICAL SOLUTION OF HYPERBOLIC EQUATIONS AND SYSTEMS BY A METHOD OF THE RUNGE–KUTTA TYPE. 2
Nguyen Kong Tuy Redstone Arsenal, Ala. Redstone Sci. Inform. Center Jun. 1968 19 p refs Transl. into ENGLISH from Vestsi Akad. Navuk Belarusk. SSR, Ser. Fiz. Mat. Navuk (Minsk), no. 1, 1966 p 60–66
(NASA-TM-X-61182; RSIC-813) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The two-iteration algorithms of the Runge–Kutta type were applied to the solution of the Cauchy problem for hyperbolic equations and systems with two independent variables, where the initial data are given along the line segment x+y=const. An analogous problem is discussed for one equation with Cauchy data along the curve segment. Author

N68-34453# Case Western Reserve Univ., Cleveland, Ohio. Systems Research Center.
COORDINABILITY IN A TWO LEVEL SYSTEM
Velimir Jurdjevic 1968 93 p
(Contract Nonr-1141(10); Grant NSF GK-1394)
(SRC-68-3; AD-672651)

The objective of this research is to study two level systems of the following form: The process P is a mapping from M = M sub 1 x M sub 2 x...x M sub n into Y = Y sub 1 x Y sub 2 x...x Y sub n, which is a subject to the performance G : MxY(arrow)V where G(m,y) = phi(G sub 1 (m sub 1, y sub 1),..., G sub n (m sub n, y sub n)) and V is a linearly ordered set. G sub i (m sub i, y sub i) are the first level performances for the subprocesses y sub i = P sub i (m). The goal of the system is minimization of G(m,P(m)). Author (TAB)

N68-34454# Illinois Univ., Urbana. Coordinated Science Lab.
AN APPROXIMATE DESIGN OF OPTIMAL REGULATORS FOR HIGH-ORDER LINEAR PLANTS

P. Sannuti and P. Kokotovic May 1968 19 p refs
(Contract DAAB-07-67-C-0199; Grant AF AFOSR-931-67)
(R-383; AD-672485)

It is show that the state feedback matrix of a linear system optimal with respect to a quadratic performance index can be expanded in a MacLaurin series in parameters which change the order of the system. The first two terms of this series are employed in an optimally sensitive design for a high-order plant. The result of the optimally sensitive design is superior to that achieved by a conventional low-order design, while the amount of computation is considerably lower than it is required for a high-order design. An example of a second order design for a fifth order plant is given. Author (TAB)

N68-34456*# Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center.
NUMERICAL SOLUTION OF HYPERBOLIC EQUATIONS AND SYSTEMS WITH TWO INDEPENDENT VARIABLES BY A METHOD OF THE RUNGE–KUTTA TYPE. 1
Nguyen Kong Tuy Jun. 1968 25 p refs Transl. into ENGLISH from Vestsi Akad. Navuk Belarusk. SSR, Ser. Fiz.–Mat. Navuk (Minsk), no. 4, 1965 p 110–120
(NASA-TM-X-61184; RSIC-811) CFSTI: HC $3.00/MF $0.65 CSCL-12A

The application of two-iteration Runge–Kutta algorithms in the solution of the Cauchy problem for hyperbolic equations and systems with two independent variables is discussed. Author

N68-34505# Texas A&M Univ., College Station. Station Inst. of Statistics.
NONLINEAR PROGRAMMING IN MULTIPLE RESPONSE OPTIMIZATION PROBLEMS
R. R. Hocking, P. L. Claypool, and C. G. Ohlendorf 2 May 1968 83 p refs
(Contract N00014-68-A-0140)
(TR-1; AD-672362)

A parametric programming algorithm is developed which will allow one to solve a sequence of closely related convex programming problems sequentially. This algorithm is developed in such a manner as to become an extension to the general convex programming algorithm developed by Hartley and Hocking (1963). In terms of statistical response surface analysis, convex parametric problems arise when it is desirable to simultaneously optimize a number of response surface functions within a given experimental region. In general, this is not possible, however, one may choose to optimize a specified one of these response surface functions subject to the conditions that the others achieve certain desired activity levels. In many situations these activity levels are not clearly defined and a parametric study over several combinations of values of meaningful activity levels is indicated. Extensions of the parametric procedure allows for the solution of non-convex quadratic programming problems with quadratic restrictions in the sense that at least one and usually several local optima are obtained. Combining the parametric study with the ability to handle non-convex functions will allow a thorough analysis of the multiple response problem. Author (TAB)

N68-34558# Research Analysis Corp., McLean, Va. Advanced Research Dept.
AN ALGORITHM FOR SEPARABLE NONCONVEX PROGRAMMING PROBLEMS
James E. Falk and Richard M. Soland Jul. 1968 37 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-319; AD-672084)

An algorithm is presented for solving mathematical programming problems of the form: Find chi = (chi sub one, ..., chi sub n) to minimize Summation (Phi sub i (chi sub i)) subject to chi) an element of G and l = or < chi = or < L. Each Phi sub i is assumed to be lower semicontinuous, possibly nonconvex, and G is assumed to be closed. The algorithm is of the branch-and-bound type and solves a sequence of problems in each of which the objective function is convex. These problems correspond to successive partitions of the feasible set. Two different rules for refining the partitions are considered; these lead to convergence of the algorithm under different requirements on the problem functions. Examples are given and computational considerations are discussed. Author (TAB)

N68-34583# Los Alamos Scientific Lab., N. Mex.
SUBROUTINES FOR COMPUTING AND GRAPHING LEVEL LINES OF FUNCTIONS OF TWO VARIABLES
H. Ralph Lewis 20 Jun. 1968 10 p
(Contract W-7405-ENG-36)
(LA-3877) CFSTI: HC $3.00/MF $0.65

FORTRAN subroutines for computing and graphing level lines of an arbitrary function of two variables are described. Instructions for using the subroutines are presented with an example and listings of the computer programs. Author (NSA)

N68-34648# Oak Ridge National Lab., Tenn. Mathematics Div.
TABLES OF ARITHMETICAL FUNCTIONS RELATED TO THE FIBONACCI NUMBERS
Beth H. Hannon and William L. Morris Jun. 1968 59 p refs
(Contract W-7405-ENG-26)
(ORNL-4261) CFSTI: HC $3.00/MF $0.65

Tables of five arithmetical functions related to the Fibonacci numbers are presented. Function values are given for all arguments up to and including 15,600. Since two of these functions have only recently been discovered, these tables are essentially new. Author (NSA)

N68-34652# California Univ., Berkeley. Dept. of Mathematics.
SINGULAR PERTURBATION THEOREMS FOR PERIODIC SURFACES OF ORDINARY DIFFERENTIAL EQUATIONS
Shih-Hung Chang Jun. 1968 50 p refs
(Contract Nonr-222(88))
(AD-672212)

Generalization of the Diliberto theory of periodic surfaces to the case of singular perturbation has been made. In this paper two basic types of singularly perturbed systems of ordinary differential equations have been investigated and the existence, continuous dependence on parameter and uniqueness of periodic surfaces have been obtained. Author (TAB)

N68-34668# RAND Corp., Santa Monica, Calif.
FINDING MINIMAL COST-TIME RATIO CIRCUITS
Bennett Fox Jun. 1968 16 p refs
(Contract F44620-67-C-0045)
(RM-5696-PR; AD-672256)

An efficient method is given for finding minimal cost-time ratio circuits in routing problems through the use of the out-of-kilter algorithm. The problem of finding a cycle in a network having a minimal cost-to-time ratio has been considered previously, and column generators have been used to introduce, into the basis of the master problem, the solution that corresponds to this cycle. The subproblem is of independent interest and corresponds to deterministic single chain Markov renewal programming. The main difference between earlier approaches and the present one is that where others have used a shortest path method corresponding to the simplex method (except that steepest descent is not used), here the flow circulation problem for optimal cost-time tradeoff is solved parametrically by the out-of-kilter algorithm. Author (TAB)

N68-34669# California Univ., Berkeley. Dept. of Mathematics.
RANDOM ORDINARY DIFFERENTIAL EQUATIONS Technical Report, Sep. 1967–Jun. 1968
R. Edsinger Jun. 1968 52 p refs
(Contract Nonr-222(88))
(AD-672207)

Existence and uniqueness theorems are proved for solutions (in the mean) of the random differential equation x = f(t,x,omega). This is accomplished by determining when a sample path solution is also a solution in the mean. The usual definition of mean stability is generalized to a more useful form. Theorems are developed which relate this general type stability to the stability of the average problem. Finally theorems relating almost sure stability with the stability of the average problem are proved. Author (TAB)

N68-34686# Connecticut Univ., Storrs. Dept. of Statistics.
FOURIER SERIES AND CHEBYSHEV POLYNOMIALS IN STATISTICAL DISTRIBUTION THEORY Research Report
Jimmie D. Woods and Harry O. Posten Jul. 1968 144 p refs
(Contract Nonr-3292(03))
(RR-37; AD-672346)

After the elementary functions, the Fourier series are the most important functions in applied mathematics. Nevertheless, they have been somewhat neglected in statistical distribution theory In this paper, the reasons for this omission are investigated and certain modifications of the Fourier series proposed. These results are presented in the form of representation theorems. In addition to the basic theorems, computational algorithms and procedures are developed. As an illustration, a useful representation of the incomplete beta function ratio is developed. Although the representation theorems have been developed for those random variables whose range is contained in the intervals (0,1) and (-1,1), methods of using the theorems for other intervals are discussed. In addition, multivariate analogues of the theorems are presented. The usefulness of the representation theorems extends beyond the evaluation of a distribution function. In particular, they are useful in investigating the accuracy of an approximation to a distribution function and can be used to improve the accuracy of such an approximation. As a final application of the procedures, three important distribution problems are discussed. These are the likelihood ratio tests, products of independent beta variables, and quadratic forms. Author (TAB)

N68-34698*# Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center.
ON BILATERAL APPROXIMATION IN THE NUMERICAL INTEGRATION OF CAUCHY'S PROBLEM FOR ORDINARY DIFFERENTIAL EQUATIONS
S. Z. Zarubych Jun. 1968 15 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Uk. SSR (Kiev), no. 10, 1965 p 1278–1282
(NASA-TM-X-61183; RSIC-812) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A pair of Runge–Kutta type formulas is constructed so that the exact solution of a differential equation in a certain interval x_0, b, is contained between two approximate numerical solutions; one solution is below, the other is above. The method makes it possible to construct bilateral formulas with a high degree of accuracy. Author

N68-34708# Michigan Univ., Ann Arbor. Industrial Engineering Dept.
GEOMETRIC PROGRAMMING: DUALITY IN QUADRATIC PROGRAMMING AND L_p APPROXIMATION
Elmor L. Peterson and Joseph G. Ecker 1968 127 p refs
(Contract DA-ARO(D)-31-124-0767)
(TR-1968-2; AROD-5447.4-M; AD-672098)

The duality theory of geometric programming as developed by Duffin, Peterson and Zener is based on abstract properties shared by certain classical inequalities, such as Cauchys arithmetic-geometric mean inequality and Holders inequality. Inequalities with these abstract properties have been termed geometric inequalities. In this paper we establish a new geometric inequality and use it to extend the refined duality theory for posynomial geometric programs. This extended duality theory treats both quadratically-constrained quadratic programs and l sub p-constrained l sub p-approximation (regression) problems through a rather novel and unified formulation of these two classes of programs. This work generalizes some of the work of others on linearly-constrained quadratic programs, and provides to the best of our knowledge the first explicit formulation of duality for constrained approximation problems. Other people have developed duality theories for a larger class of programs, namely all convex programs, but those theories (when applied to the programs considered here) are not nearly as strong as the theory developed here. This theory has virtually all of the desirable features of its analog for posynomial programs, and its proof provides useful computational procedures. Author (TAB)

N68-34713# Boeing Scientific Research Labs., Seattle, Wash. Information Sciences Lab.
A DATA STRUCTURE CALCULUS FOR MATRICES
Rudolf Bayer and Christoph Witzgall May 1968 72 p refs
(DI-82-0726; Rept.-20; AD-672149)

A matrix calculus is introduced with the intention to develop data structures suitable for a high level algorithmic language for Mathematical Programming. The paper investigates how the special structure of matrices can be described and utilized for efficient computing by saving memory space and avoiding superfluous operations. The power of the calculus is increased by introducing lists, lists of lists, etc. of matrices and by extending ordinary matrix operators to list operators and cumulative operators over lists. Effective algorithms are given which use symbolic manipulations of matrix and list expressions so as to find the forms best suited for computation. These forms are called normal forms. Several completeness results are obtained in the sense that for each expression an equivalent expression in normal form can be found within a specified calculus. Author (TAB)

N68-34716# Michigan Univ., Ann Arbor. Dept. of Industrial Engineering.
CRITICAL PATH METHOD: A REVIEW
M. Krishnamoorthy 1968 112 p refs
(Grant DA-ARO(D)-31-124-G767)
(AROD-5447-5-M; TR-1968-4; AD-672522)

The paper brings together different aspects of the Critical Path Analysis exclusively in terms of the mathematical developments in this area during the last eight years. The survey is divided into seven sections. The first one deals with the four stages of development, each successive stage being more representative of the real situation. The next five sections give explicit reference to the different articles which contribute to the stages of development described in the first section. The articles are reviewed in terms of the network algebra, PERT assumptions, cost/time trade off, resource allocation (heuristic) and resource allocation (analytical). Finally, the seventh and last section of this paper provides a summary of ideas and possible directions of research, some of which are currently being undertaken. Author (TAB)

N68-34719# Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
AN ADAPTIVE GROUP THEORETICAL ALGORITHM FOR INTEGER PROGRAMMING PROBLEMS

G. Anthony Gorry and Jeremy F. Shapiro 31 May 1968 70 p refs
(Contract DA-31-124-ARO-D-209)
(TR-39; AD-672099)

A prototypical algorithm for solving integer programming problems is presented. The algorithm combines group theoretic methods for finding integer solutions to systems of linear equations under the control of heuristic supervisory procedures. The latter pre-structure the overall problem and guide the search for an optimal solution by organizing subproblems and selecting the appropriate analytical methods to apply to them. Here there is a decided emphasis on the diagnostic facility of the supervisor in order that the various analytic methods may be adapted to the overall problem and to the particular subproblems encountered. Throughout the paper, the variety and flexibility of the group theoretic methods are emphasized, as well as the potential of heuristic selection and control of these methods. Author (TAB)

N68-34761*# Delaware Univ., Newark.
A REPRESENTATION FORMULA FOR THE SOLUTIONS OF THE SECOND ORDER LINEAR DIFFERENTIAL EQUATION
E. J. Pellicciaro May 1968 8 p refs Presented at the 65th Ann. Meeting of the N. C. Acad. of Sci., Greensboro, N. C., 10–11 May 1968
(Grant NGR-08-001-016)
(NASA-CR-96817) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Let p and q be continuous functions on a bounded closed interval I containing x_0. A simple existence and uniqueness proof is given for the initial value problem (1) $y'' - py' - qy = 0$, $y(x_0) = y_0$, $y'(x_0) = y'_0$, with y_0 and y'_0 arbitrary numbers. A product of the proof is a representation formula for the solution of (1). That the representation formula is indeed a solution under the hypothesis stated can be verified by direct substitution into (1). Author

N68-34775*# Midwest Research Inst., Kansas City, Mo.
AN INTEGRAL TRANSFORM WITH A WHITTAKER FUNCTION KERNEL Interim Report, 20 Jun.–19 Aug. 1968
Jet Wimp 30 Aug. 1968 10 p refs
(Contract NAS9-7641; MRI Proj. 3162-P)
(NASA-CR-92264) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An integral transform is investigated whose kernel contains a Whittaker function. In both the transform and its inversion formula, integration is performed with respect to a parameter of the function, and thus the result is altogether different in form from previous transform pairs. Author

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N68-33771# Finnish Meteorological Office, Helsinki.
OBSERVATIONS OF RADIOACTIVITY, NO. 7, 1967 [RADIOAKTIIVISUUSHAVAINTOJA, NO. 7, 1967]
1968 74 p ref
CFSTI: HC $3.00/MF $0.65

Atmospheric radioactivity measurements were made at 11 stations in various parts of Finland. The recordings were converted into hourly, daily, or weekly values and are presented in tables grouped according to fractions of aerosol beta activity (1) decaying within four hours of the end of a four hour sampling period, and (2) remaining three days after the end of the sampling period. Measurements of beta activity in precipitation and settled dust collected at Helsinki and Ivalo are included. Instruments, measuring systems, facilities, and locations are also briefly described. K.W.

N68-33898# Miami Univ., Coral Gables, Fla. Inst. of Atmospheric Sciences.
HURRICANE STUDIES. PART 1: CUMULUS AND SMALL-SCALE EXCHANGE PROCESSES IN HURRICANES. PART 2: PRELIMINARY REPORT ON MODELLING THE MATURE HURRICANE Final Report
Mariano A. Estoque and Jose J. Fernandez-Partagas Mar. 1968 70 p refs *Its* Paper 2
(Grant E-19-67(G))
(PB-178529) CFSTI: HC $3.00/MF $0.65

Estimates of the magnitude of the exchange processes associated with cumulus and smaller scale fluctuations are obtained. The estimates are obtained as residuals after computing the terms involving the mean quantities in the momentum and the thermodynamic energy equations. The results confirm the idea that cumulus convection plays an important role in increasing both heat and momentum in the upper troposphere. In addition, they show that the mixing length hypothesis alone may not be able to describe completely the exchange processes in hurricanes. Author (USGRDR)

N68-33988# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 70, NO. 5: WEATHER SATELLITE OBSERVATIONS AND THEIR VALUE TO THE EUROPEAN WEATHER PICTURE, 1966. PART 5: NOVEMBER–DECEMBER 1966 [METEOROLOGISCHE ABHANDLUNGEN. BAND 70, HEFT 5: WETTERSATELLITENBEOBACHTUNGEN UND IHRE AUSWERTUNG DAS EUROPAEISCHE WETTERBILD 1966. TEIL 5: NOVEMBER–DEZEMBER 1966]
Ingrid Haupt et al 1967 196 p refs In GERMAN; ENGLISH summary CFSTI: HC $3.00/MF $0.65

The ATS-1 (Application Technology Satellite) is described, including its technical and meteorological programs, orbital characteristics, and its special system of camera equipment, the Spin Scan Cloud Cover Camera, which photographs always the same area of the earth from a synchronous, stationary orbit of about 36,000 km. The daily European weather situation and some data on the snow and ice conditions are presented in the form of Nimbus 2 cloud mosaics, tables, and short descriptions. The most important orbital data of ESSA 2 and Nimbus 2 are included. November and December of 1966 are covered. K.W.

N68-34163# Imperial Coll. of Science and Technology, London (England). Dept. of Meteorology.
THE CYCLONE PROBLEM: A HISTORY OF MODELS OF THE CYCLONIC STORM
F. H. Ludlam 8 Nov. 1966 37 p
CFSTI: HC $3.00/MF $0.65

The history of the circular theory of wind patterns and the first flow-models of middle-latitude cyclones are recalled. The era of the first synchronous observations and weather maps leading to the cyclone flow-models of Fitzroy and Jinman are remembered. The polar-front wave and the baroclinic wave theory of cyclones are reviewed. ESRO

N68-34244*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE REMOTE SENSING OF STRATOSPHERIC TEMPERATURES AND SOME RESULTS FROM THE NIMBUS 2 SATELLITE EXPERIMENT
Guenter Warnecke Sep. 1967 42 p refs Presented at the 7th Stanstead Seminar, Stanstead, Can., 4 Aug. 1967 Submitted for publication
(NASA-TM-X-60413) CFSTI: $3.00 CSCL 04B

The Nimbus II medium resolution infrared radiometer measured atmospheric radiation in five spectral regions. Radiance

measurements in a two-micron-wide spectral interval within the 15 micron carbon dioxide band permitted the derivation of vertically averaged stratospheric temperatures and made possible the daily monitoring of global stratospheric temperature patterns. The experiment lasted from May 15 through July 28, 1966. For this period, stratospheric temperature maps were produced by a computer program which included a method to eliminate the effect of dense high clouds on the 14 and 16 micron measurements. The method of measurement, the applied correction model, and some results of the Nimbus II experiment are described. Due to the seasonal restriction of the experiment, the derived global stratospheric temperature distributions exhibit the most interesting events over the Southern Hemisphere. Author

N68-34246*# Chicago Univ., Ill. Dept. of the Geophysical Sciences.

AERIAL MEASUREMENT OF RADIATION TEMPERATURES OVER MT. FUJI AND TOKYO AREAS AND THEIR APPLICATION TO THE DETERMINATION OF GROUND- AND WATER-SURFACE TEMPERATURES

Tetsuya Fujita, Gisela Baralt, and Kiyoshi Tsuchiya (Japan Meteorol. Agency) Mar. 1968 35 p refs Prepared in cooperation with Japan Meteorological Agency

(Grants NsG-333; CWB-WBG-34)

(NASA-CR-96693; SMRP-RP-72; PB-178404) CFSTI: HC $3.00/MF $0.65 CSCL 04B

A portable radiometer with a spectral response in the 8–14 micron range was used to determine the equivalent blackbody temperature of (1) the slope of Mt. Fuji, (2) Sagami Bay, and (3) the city of Tokyo. A twin-engine aircraft was used to fly over these areas at various altitudes up to 12,000 ft. Through mapping the slope temperatures of Mt. Fuji, it was learned that the rocky slope heats up under the morning sun very rapidly to 32°C almost irrespective of the elevation. The distribution of measured temperatures explains the reasons for the rapid growth of cumulus clouds along the east slope in the early morning hours. The nadir-angle and the height dependence of equivalent blackbody temperatures measured over Tokyo and Sagami Bay was examined. The measured temperatures were compared with those computed from the radiative transfer equation. It was found that the values over Tokyo are reproduced fairly well by the addition of a graybody smog filling the layers up to 910 mb. Author (USGRDR)

N68-34257# Commonwealth Scientific and Industrial Research Organization, Melbourne (Australia).

RADIATION AND ASSOCIATED OBSERVATIONS MADE ON INDIAN OCEAN CRUISES. 1: CRUISES DURING 1962

E. L. Deacon and J. Stevenson 1968 23 p refs *Its* Div. of Meteorol. Phys. Tech. Paper No. 16

CFSTI: HC $3.00/MF $0.65

Measurements of the global radiation (short-wave and short-wave plus long-wave), sea surface and air temperatures, cloud amount and type, and wind speed, made on two cruises in the Indian Ocean, are tabulated, together with the net radiation income from the sea, which was calculated from these measurements. Author

N68-34290# Wisconsin Univ., Madison. Dept. of Meteorology.

STUDIES OF EFFECTS OF BOUNDARY MODIFICATION IN PROBLEMS OF SMALL AREA METEOROLOGY Annual Report, 1966–1967

Heinz H. Lettau, Charles R. Stearns, Walter F. Dabberdt, and Joseph Zabransky Feb. 1968 166 p refs

(Contract DA-AMC-28-043-66-G24)

(ECOM-66-G24-A; AD-671644)

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5. APPLICATION OF LETTAU'S THEORETICAL MODEL OF THERMAL DIFFUSION TO SOIL PROFILES OF TEMPERATURE AND HEAT FLUX C. R. Stearns p 105–126 refs (See N68-34295 21-20)

6. THREE-DIMENSIONAL TURBULENCE IN UNIDIRECTIONAL MEAN FLOW H. H. Lettau p 127–156 refs (See N68-34296 21-20)

N68-34291# Wisconsin Univ., Madison. Dept. of Meteorology.

ANALYSIS OF DIABATIC WIND AND TEMPERATURE PROFILES

Charles R. Stearns *In its* Studies of Effects of Boundary Modification in Probl. of Small Area Meteorology Feb. 1968 p 1–52 refs (See N68-34290 21-20)

The major problems in the analysis of wind speed and air temperature profiles when used to determine the surface stress and sensible heat flux are the determination of the displacement height of the profiles and of the roughness of the underlying surface. The method discussed here involves two theoretical models of profile structure. The method of analysis weights equally each measurement of wind and temperature. The selection of the displacement height and the surface roughness is based on the minimum error squares fit between the profile points and the theoretical model in the determination of the surface stress. An estimate of the sensible heat flux to the air results which is then compared to an independent measurement of the sensible heat flux. Author

N68-34292# Wisconsin Univ., Madison. Dept. of Meteorology.

INTERRELATED CHANGES OF WIND PROFILE STRUCTURE AND RICHARDSON NUMBER IN AIR FLOW FROM LAND TO INLAND LAKES

Heinz H. Lettau and Joseph Zabransky *In its* Studies of Effects of Boundary Modification in Probl. of Small Area Meteorology Feb. 1968 p 57–79 refs (See N68-34290 21-20)

A semi-empirical model for wind profile modification in air flow from land to water on the 2 km scale, is discussed using 1950 Lake Hefner data. Initial (rough surface) and final (smooth surface) profiles are derived and an interpolation model is developed and used to calculate intermediate profiles. A distribution of vertical velocity with height is determined with the aid of the assumption that the divergence in the x-direction near the surface is compensated by convergence in the y-direction aloft. The rate of growth of the internal boundary layer follows as a direct consequence of the model. Theoretical computation is compared to Super's (1964) observations of wind profile variations with fetch on Lake Mendota. A diurnal variation of subsidence, found over Lake Hefner, is related to the variation in thermal stratification and its effect on the wind profile structure. Momentum budgets between land and lake are constructed and give evidence of a diurnal variation in surface stress over Lake Hefner. Author

N68-34293# Wisconsin Univ., Madison. Dept. of Meteorology.

WIND DISTURBANCE BY A VERTICAL CYLINDER IN THE ATMOSPHERIC SURFACE LAYER

Walter F. Dabberdt *In its* Studies of Effects of Boundary Modification in Probl. of Small Area Meteorology Feb. 1968 p 81–90 refs (See N68-34290 21-20)

(Contract DA-36-039-AMC-00878(E))

The velocity distribution in the neighborhood of a cylindrical obstacle was measured over the frozen surface of Lake Mendota, Madison, Wisconsin. Reductions in wind speed of six percent are noted upwind and greater than forty percent downwind. Crosswind increases of five percent and more occur. The upwind isotach pattern is fairly well represented by the potential solution. The more complex downwind pattern is asymmetrical about the centerline. Large vertical components of the velocity are observed. Author

N68-34294# Wisconsin Univ., Madison. Dept. of Meteorology.
TOWER-INDUCED ERRORS IN WIND PROFILE MEASUREMENTS
Walter F. Dabberdt *In its* Studies of Effects of Boundary Modification in Probl. of Small Area Meteorology Feb. 1968 p 91–104 refs (See N68-34290 21-20)

An investigation of the effect of a meteorological tower on the measurement of wind speed was conducted at Brookhaven National Laboratory. Reductions up to 35% occur in the wake. The distribution of the velocity deficit in the wake is nearly Gaussian; corrections based on this distribution have improved wind data in a trial case. A slight dependence on atmospheric stability was detected; the deficit appears to be independent of the wind speed. Author

N68-34295# Wisconsin Univ., Madison. Dept. of Meteorology.
APPLICATION OF LETTAU'S THEORETICAL MODEL OF THERMAL DIFFUSION TO SOIL PROFILES OF TEMPERATURE AND HEAT FLUX
Charles R. Stearns *In its* Studies of Effects of Boundary Modification in Probl. of Small Area Meteorology Feb. 1968 p 105–126 refs (See N68-34290 21-20)
(Grant NSF GP-444)

Diurnal cycles of soil temperatures and heat flux measured on the Pampa de La Joya, Peru, are analyzed harmonically. A theory of thermal diffusion put forth by Lettau (1963) is used to determine the relative calibration of the soil heat flux plates and the relative depth intervals between the flux plates in comparison to the soil temperature profile. The absolute value of the soil heat flux is based on the allowed range of values for the volumetric heat capacity or soil density. Author

N68-34296# Wisconsin Univ., Madison. Dept. of Meteorology.
THREE-DIMENSIONAL TURBULENCE IN UNIDIRECTIONAL MEAN FLOW
Heinz H. Lettau *In its* Studies of Effects of Boundary Modification in Probl. of Small Area Meteorology Feb. 1968 p 127–156 refs (See N68-34290 21-20)
(Grant WRC-67-015M)

The coupling between mean and fluctuating velocities in fully developed turbulence is investigated with special consideration of unidirectional mean shear flow past a solid boundary. Eulerian equivalents of three dimensional eddy displacements are defined which are shown to possess important properties of isotropy. Reynolds averaging of them results in variances and covariances which yield, in addition to the conventional (or lateral) length scale of wall turbulence and the Karman constant, a set of longitudinal length scales, also another constant for which the name "Laufer constant" is proposed, and a new rationale for Prandtl's kinematic relation between mean shear and friction velocity. Literature data on nondimensional variances of turbulent fluctuations in the center region of a two dimensional channel, as well as in the vicinity of the earth air interface (as related to micrometeorological wind profiles in adiabatic surface layers) are investigated and interpreted with the aid of the new model. Author

N68-34300# Army Electronics Research and Development Activity, Fort Huachuca, Ariz. Atmospheric Sciences Lab.
A SOLUTION TO THE INTEGRAL EQUATIONS FOR RADIATIVE TRANSFER OF HEAT IN THE ATMOSPHERE
Robert D. Boudreau Aug. 1968 88 p refs
(ECOM-6034; AD-672473)

Analytic solutions to the integral equations for the radiative transfer of heat in a horizontally homogeneous, dustless atmosphere are derived in this study. It is assumed that the upward radiation from the underlying earth can be treated as blackbody radiation. The transmissivity of the atmosphere is taken to be given by a sum of exponentials which are functions of the precipitable depth of water vapor, the major radiating gas in the atmosphere. Specifying an exponential form for atmospheric transmissivity permits the integration of the transfer equations, provided that the vertical distribution of the fourth power of temperature is expressed as a polynomial function of precipitable water. Hence, the problem of radiative transfer of heat is reduced to the problem of polynomial approximation. Author (TAB)

N68-34339# Air Weather Service, Scott AFB, Ill.
CLIMATOLOGICAL ESTIMATES OF CLOCK-HOUR RAINFALL RATES
Donald C. Winner Jun. 1968 30 p refs
(AWS-TR-202; AD-672221)

The report expounds on an empirical method for estimating the clock-hour rainfall rates at a station when the mean annual rainfall amount and mean annual number of days with measurable rainfall are known. A climatic weighting factor is introduced in the calculations employing the use of Thornthwaites moisture index. Nomograms for estimating the clock-hour rainfall rates for temperate regions and also for tropic regions are included in the report. Author (TAB)

N68-34383 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 93, NO. 1: DAILY GROUND AND 850 mb MAPS OF THE NORTHERN HEMISPHERE IN 1968 Quarterly Report, 1 Jan.–31 Mar. 1968 [METEOROLOGISCHE ABANDLUNGEN. BAND 93, HEFT 1: TAEGLICHE BODEN- UND 850-mb-KARTEN DER NORDHEMISPHAERE IM JAHRE 1968 Vierteljahrteljahr, 1 Jan.–31 Mar. 1968]
Manfred Geb, Richard Scherhag, Klaus Buhlmann, Stanislaw Debenec, and Hanelore Wollschlaeger 31 Mar. 1968 187 p In GERMAN
(QR-1)

These daily synoptic charts are presented without commentary in the form of stereographic projections, scale 1:75,000,000. Transl. by K.W.

N68-34433*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WEATHER: ITS EFFECT ON LANDING-SITE SELECTION FOR FUTURE EARTH ORBITAL RECOVERY OPERATIONS
Paul F. Holloway May 1968 8 p refs Presented at the 3rd Natl. Conf. on Aerospace Meteorology, New Orleans, 6–9 May 1968
(NASA-TM-X-61227) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Use of climatological summaries in the selection of landing sites was considered in terms of meteorological environment effects on site selection for earth orbital recovery operations. Analysis was made of increasing the maneuverability of the entry vehicle, with clear weather defined as 3/10 or less cloud cover. Increased maneuverability was shown to markedly improve the probability of clear weather during recovery, not only because the higher performance vehicle can reach more of the sites for most orbits, but

also because sites with a higher probability of clear weather can be included in the network. Effects of site selection constraints were considered, as was ranging capability for both return opportunity and site selection. A basic four-site network includes Edwards AFB, California; Dhahran, Saudi Arabia; Alice Springs, Australia; and Reggan, Algeria. The additional seven sites for an 11-site network are Ambala, India; Langley AFB, Virginia; Moron, Argentina; Perth, Australia; Moron, Spain; Hickam AFB, Hawaii; and Gertzog, South Africa. M.W.R.

N68-34450# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
ATMOSPHERIC STRUCTURE. PART 3: UPPER AIR DATA HOLLOMAN SITE
Marjorie M. Hoidale, J. Barbara Gee, and George W. Harmon May 1968 243 p
(DR-321, Pt. 3; AD-672063)

A statistical analysis of upper air data is presented for Holloman Site, White Sands Missile Range, New Mexico. Atmospheric parameters covered, for the layer 6,000 to 100,000 feet above mean sea level, are: wind, temperature, pressure, density, moisture, index of refraction, and freezing level. This climatological information is based on the period of observation from 1961-1967. Author (TAB)

N68-34517# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOLOGICAL DATA. VOLUME 70, NO. 4: WEATHER SATELLITE OBSERVATIONS AND THEIR VALUE TO THE EUROPEAN WEATHER PICTURE, 1966. PART 4: SEPTEMBER–OCTOBER 1966. [METEOROLOGISCHE ABHANDLUNGEN. BAND 70, HEFT 4: WETTERSATELLITENBEOBACHTUNGEN UND IHRE AUSWERTUNG DAS EUROPAEISCHE WETTERBILD 1966. TEIL 4: SEPTEMBER–OKTOBER 1966]
Ingrid Haupt et al 1967 188 p refs In GERMAN; ENGLISH summary
CFSTI: HC $3.00/MF $0.65

Summaries of the daily European weather situation for September and October of 1966 are presented based on evaluated cloud photographs of Nimbus 2 and Essa 2. The corresponding orbital data for the satellites are also given. Technical and operational data of the Essa 3 satellite are discussed, and a brief article treats the principles of producing digitized cloud maps. The snow and ice conditions in central and eastern Europe for the report period are summarized. Transl. by K.W.

N68-34519# RAND Corp., Santa Monica, Calif.
NUMERICAL MODELING OF CONDENSATION
L. R. Koenig Aug. 1968 50 p refs
(Contract NSF C-415)
(RM-5553-NSF) CFSTI: HC $3.00/MF $0.65

Molecular diffusion causing mass transfer to and from cloud droplets is modeled by two systems of equations. Predictions of growth behavior made by the two systems are compared with one another and with other formulations in the literature, using Euler, Adams–Moulton, and Runge–Kutta integration procedures. The effects of various embellishments, such as corrections to diffusion and conductivity coefficients, are examined. The numerically simpler model, without embellishments and integrated by the Euler method, is judged adequate for most meteorological purposes. Author

N68-34683# Stanford Research Inst., Menlo Park, Calif.
URBAN CLIMATOLOGICAL STUDIES Final Report
Francis L. Ludwig and Joyce H. S. Kealoha Mar. 1968 193 p refs
(Contract DAHC20-67-C-0136)
(AD-672071)

The report gives the results of a temperature and humidity measurement program in the Dallas area during the summer of 1967. Results are presented in the form of horizontal time sections of temperature and absolute humidity analogous to the commonly used vertical time sections of meteorology. This mode of analysis was found to be very useful in presenting the temporal and spatial variations of temperature and humidity in an urban area. Analyses revealed that areas of densely packed 4- and 5-story buildings are the warmest parts of Dallas during the day, with the area of high-rise buildings somewhat cooler and the residential and open vegetated areas cooler still. This study confirms the presence of the warm area (or heat-island) in the center of town at night, a phenomenon observed in many other studies. Absolute humidities in town were strongly affected by the balance between moisture release at the surface and mixing to higher levels. Author (TAB)

N68-34783# Chicago Univ., Ill. Dept. of the Geophysical Sciences.
CLOUD PHYSICS LABORATORY
15 Aug. 1968 105 p refs Sponsored by NSF
(TN-38)

CONTENTS:

1. METEOROLOGICAL BASES FOR PRECIPITATION DEVELOPMENT R. R. Braham, Jr. 11 p refs (See N68-34784 21-20)
2. SURVIVAL OF CIRRUS CRYSTALS IN CLEAR AIR R. R. Braham, Jr. and P. Spyers–Duran 9 p refs (See N68-34785 21-20)
3. THERMOELECTRIC POWER OF SINGLE CRYSTALS OF ICE CONTAINING HF OR NH_3 G. W. Bryant 10 p refs (See N68-34786 21-20)
4. CAMERA ORIENTATION FOR CLOUD MEASUREMENTS E. L. Harrington 7 p refs (See N68-34787 21-20)
5. AN EMPIRICAL EXAMINATION OF CUMULUS ENTRAINMENT P. W. Sloss 4 p refs (See N68-34788 21-20)
6. AN AIRBORNE CONTINUOUS CLOUD PARTICLE REPLICATOR P. A. Spyers-Duran and R. R. Braham, Jr. 7 p refs (See N68-34789 21-14)
7. DISCUSSION OF EXPERIMENTATION WITH WEATHER CONTROL R. R. Braham, Jr. and J. A. Flueck 5 p refs (See N68-34790 21-20)
8. A STATISTICAL ANALYSIS OF PROJECT WHITETOP'S PRECIPITATION DATA J. A. Flueck 18 p refs (See N68-34791 21-20)
9. INITIAL PRECIPITATION ECHO IN CLOUDS THAT COMBINE TO FORM A THUNDERSTORM E. L. Harrington 6 p refs (See N68-34792 21-20)
10. PARTITIONING OF WATER BETWEEN CLOUD DROPS AND PRECIPITATION PARTICLES IN CUMULI R. Lyons 7 p refs (See N68-34793 21-20)
11. COMPUTER MODEL COMPARISON OF SEEDED AND NOT-SEEDED CONVECTIVE CLOUD DEPTH USING PROJECT WHITETOP DATA J. McCarthy 9 p refs (See N68-34794 21-20)

N68-34784# Chicago Univ., Ill.
METEOROLOGICAL BASES FOR PRECIPITATION DEVELOPMENT
Roscoe R. Braham, Jr. *In its* Cloud Phys. Lab. 15 Aug. 1968 (See N68-34783 21-20) 11 p refs Repr. from Bull. Am. Meteorol. Soc., v. 68, no. 4, Apr. 1968 p 343–353 refs Presented at AAAS Symp. on Weather Modification in Arid Lands, New York, 30 Dec. 1967 (See N68-34783 21-20)
(Grant NSF GA-740)

Summarized are the major points of meteorological parameters in the development of precipitation. Flow diagrams of the various processes involved and analyses of interaction links between precipitation formation and cloud dynamics give a broad outline of the

formation of stratus as well as cumulus clouds. It is concluded that ice nuclei seeding can cause some cumulus clouds to grow through stable layers that otherwise would limit their vertical development and thus lead to precipitation. G.G.

N68-34785# Chicago Univ., Ill.
SURVIVAL OF CIRRUS CRYSTALS IN CLEAR AIR
Roscoe R. Braham, Jr. and Paul Spyers-Duran *In its* Cloud Phys. Lab. 15 Aug. 1968 9 p refs Repr. from J. Appl. Meteorol., v. 6, no. 6, Dec. 1967 p 1053–1061 refs (See N68-34783 21-20)
(Grant NSF GP-3779)

During the summer of 1966 in Bemidji, Minn., aircraft collections of cirrus crystals were made with a continuous particle replicator. Actual samples show that cirrus crystal trails with concentrations of 10^5–10^6 m^{-3} can survive a fall of 20,000 ft in clear air with a temperature/dew point spread of 15C. Computations of evaporation rates for falling crystals suggest that it is somewhat surprising that the crystals could have survived under the observed conditions; however, this may have been because input data for the calculations are inadequate. Author

N68-34786# Chicago Univ., Ill. Dept. of Geophysical Sciences.
THERMOELECTRIC POWER OF SINGLE CRYSTALS OF ICE CONTAINING HF OR NH_3
G. W. Bryant *In its* Cloud Phys. Lab. 15 Aug. 1968 10 p refs Repr. from Phil. Mag., v. 16, no. 141, Sep. 1967 p 495–504 refs (See N68-34783 21-20)
(Grant NSF GP-3881)

The homogeneous thermoelectric power of single-crystalline ice containing HF or NH_3 has been measured over a wide range of concentrations. The experimental values are of the order of a few millivolts per degree centigrade and vary in sign and magnitude with the type and concentration of impurity in agreement with the theory developed by Jaccard. The results permit an estimation of several parameters relevant to conducting processes in ice. Author

N68-34787# Chicago Univ., Ill.
CAMERA ORIENTATION FOR CLOUD MEASUREMENTS
Edward L. Harrington *In its* Cloud Phys. Lab. 15 Aug. 1968 7 p refs Repr. from Photogrammetric Eng., Apr. 1968 (See N68-34783 21-20)
(Grants NSF G-8214; NSF G-22419; NSF GP-3779)

Stereoscopic photographs are used to measure height and distance of points on convective clouds. The problem is to orient a pair of cameras to the normal case for terrestrial stereophotogrammetry without permanent ground objects common to both camera fields to serve as control points. The bearing (azimuth) perpendicular to the line joining the cameras is determined. Measurements from star photographs are used to place the camera axes on this bearing at zero elevation angle with minimum swing. The systematic errors in height and distance measurement due to imperfect camera orientation are determined using error equations and values of elevation angle error and x-parallax error measured on a stereoscopic pair of star photographs. An example is shown where maximum errors due to camera orientation are 1.2 percent for distance and 0.8 per-cent for height for an object twenty miles from the reference camera. Author

N68-34788# Chicago Univ., Ill.
AN EMPIRICAL EXAMINATION OF CUMULUS ENTRAINMENT
Peter W. Sloss *In its* Cloud Phys. Lab. 15 Aug. 1968 4 p refs Repr. from J. Appl. Meteorol., v. 6, no. 5, Oct. 1967 p 878–881 refs (See N68-34783 21-20)
(Grants NSF GP-3779; NSF GP-3881)

Most analytic theories and laboratory models of cumulus entrainment predict that the rate of influx of ambient fluid into a convective element depends inversely on the diameter of the updraft zone. A study of 15 continental cumulus congestus clouds containing apparent bubble-like rising elements failed to demonstrate the predicted radius dependence. Application of a standard one-dimensional entrainment computation to the measured cloud and environment conditions revealed no significant correlation between cloud dimensions and entrainment. Author

N68-34790# Chicago Univ., Ill.
DISCUSSION OF EXPERIMENTATION WITH WEATHER CONTROL
R. R. Braham, Jr. and J. A. Flueck *In its* Cloud Phys. Lab. 15 Aug. 1968 5 p refs Repr. from J. Roy. Stat. Soc., ser. A, no. 130, 1967 p 285–326 (See N68-34783 21-20)
(Grants NSF GP-3779; NSF GA-851)

A critical summary is given on cloud seeding experiments and hypothetical deductions of precipitation likelihoods. Statistical evaluation of radar echo frequency, yearly values of seeded and unseeded rainfall, and other random parameters needs corrections of various kind if the hypothesis that seeding might produce either increases or decreases in rainfall is to be supported. G.G.

N68-34791# Chicago Univ., Ill.
A STATISTICAL ANALYSIS OF PROJECT WHITETOP'S PRECIPITATION DATA
John A. Flueck *In its* Cloud Phys. Lab. 15 Aug. 1968 18 p refs Presented at the 1st Natl. Conf. on Weather Modification, Albany, 28 Apr.–1 May 1968 Submitted for publication (See N68-34783 21-20)
(Grant NSF GA-851)

A statistical analysis of cloud seeding precipitation data in Southern Missouri over a five year period is given. Comparisons of seeded and non-seeded days by plume and non-plume effects show a strong indication of negative treatment results in at least some years. G.G.

N68-34792# Chicago Univ., Ill.
INITIAL PRECIPITATION ECHO IN CLOUDS THAT COMBINE TO FORM A THUNDERSTORM
Edward L. Harrington *In its* Cloud Phys. Lab. 15 Aug. 1968 6 p refs Presented at Am. Meteorol. Soc. Conf. on Severe Local Storms, St. Louis, 18–20 Oct. 1967 Submitted for publication (See N68-34783 21-20)
(Grants NSF G-8214; NSF G-22419; NSF GP-3779)

Stereoscopic cameras and a calibrated 3-cm height finding radar are used to measure convective clouds in Southern Missouri. A group of cumulus congestus is examined as the clouds develop precipitation echo. Some of the clouds continue to grow after precipitation initiation and combine to form a thunderstorm. Temperatures of the tops and bases of the first echoes suggest that some of the clouds initiate precipitation through coalescence of cloud drops and others through an ice process. One of the cold first echoes (base temperature −5C) occurs in association with an updraft speed estimated to be greater than 20 m sec^{-1}. The particles in this echo were carried by the strong updraft to high altitude and cold temperature in the time required to grow to precipitation size, and consequently probably contained ice. Author

N68-34793# Chicago Univ., Ill.
PARTITIONING OF WATER BETWEEN CLOUD DROPS AND PRECIPITATION PARTICLES IN CUMULI

Rick Lyons *In its* Cloud Phys. Lab. 15 Aug. 1968 7 p refs Presented at Am. Meteorol. Soc. Conf. on Severe Local Storms, St. Louis, 18–20 Oct. 1967 Submitted for publication (See N68-34783 21-20)
(Grants NSF G-8214; NSF G-22419; NSF GP-3779)

Project Whitetop provided measurements of cloud and precipitation liquid-water contents in cumulus congestus clouds. These permit a study of the partitioning of water between cloud drops and precipitation particles as a function of stage of cloud development and environmental parameters. It is found that the ratio of precipitation water to cloud water increases considerably as downdrafts appear in the cloud and subsequently decreases from precipitation fallout. The data show that the ratio is correlated to vertical thickness of the cloud and to magnitude of the vertical wind shear vector; the liquid water content distribution in a horizontal plane through the cloud appears to be related to the direction of the vertical wind shear vector. Author

N68-34794# Chicago Univ., Ill.
COMPUTER MODEL COMPARISON OF SEEDED AND NOT-SEEDED CONVECTIVE CLOUD DEPTH USING PROJECT WHITETOP DATA
John McCarthy *In its* Cloud Phys. Lab. 15 Aug. 1968 9 p refs Presented at the 1st Natl. Conf. on Weather Modification, Albany, 28 Apr.–1 May 1968 Submitted for publication (See N68-34783 21-20)
(Grant NSF GA-740)

A set of atmospheric soundings was used in this computerized analysis to calculate the vertical convective cloud depth of a hypothetical test cloud as applied to a variety of assumed glaciation levels. Comparisons between the computed vertical cloud depth were made in an effort to obtain the expected seeding effects during summer time. Evaluation of about 198 operational days and their representative glaciation levels showed that overall seedability decreased when the level of natural glaciation became successively warmer. Small radii clouds had a larger seedability on 55 percent of sampled days than larger clouds. The greatest seedability occurred when the mean lapse rate was between 7 and 8°C km^{-1} while the magnitude of the seedability fell off sharply in both directions from this range of values. G.G.

N68-34805# Alaska Univ., College. Geophysical Inst.
THE FAIRBANKS FLOOD OF AUGUST 1967. SOME METEOROLOGICAL ASPECTS AND COMMENTS
Neil A. Streten Oct. 1967 21 p refs
(Grant NSF GA-900)
(UAG-R-204)

The disastrous mid-August 1967 flooding of the Chena River at Fairbanks, Alaska, followed a wet late summer period associated with an unusual circulation pattern in the Arctic basin. Moisture inflow from the west Pacific, continued low pressure in the Beaufort Sea, and an expansion of the North Pacific high resulted in strong southwesterly flow over southern Alaska. Orographic channeling and uplift contributed to local heavy rainfall and the resulting flood was more severe than that commonly accompanying spring thaws. Brief comments are made on the development of a better network for the study of the flood hydrology of the catchment. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N68-33756*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LOAD RELIEF AUTOPILOT ANALYSIS TO MINIMIZE LAUNCH VEHICLE PEAK THRUST VECTOR DEFLECTION REQUIREMENTS
Leslie L. Scalzott and Fred Taren Washington Sep. 1968 42 p refs
(NASA-TN-D-4788) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A load relief autopilot design to minimize the maximum thrust vector deflection angle required to maintain vehicle stability during flight through design winds is analyzed. The feedback variables are angle of attack and flight path angle as well as attitude error and rate. A rigid body configuration is assumed, and sensor dynamics are not considered. Deflection angle and attitude error responses are presented for design winds. It is shown that the load relief autopilot analyzed results in a 60 percent decrease in deflection requirements for these winds as compared to a conventional autopilot designed to trim the vehicle. Author

N68-33827*# Analytical Mechanics Associates, Inc., Lanham, Md.
SUBOPTIMAL FILTERING. PART 1: ADAPTIVE FILTERING Final Report
Andrew H. Jazwinski, Stanley F. Schmidt, Ann E. Bailie, and Norman Levine May 1968 19 p refs To be Presented at the IFAC Symp. on Multivariable Control Systems, Duesseldorf, 7–8 Oct. 1968
(Contract NAS5-11048)
(NASA-CR-96540; Rept.-68-12, Pt. 1) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Applications of the Kalman filter in orbit determination problems have sometimes encountered a difficulty which has been referred to as divergence. The phenomenon is a growth in the residuals; the state and its estimate diverge. This problem can often be traced to insufficient accuracy in modeling the dynamics used in the filter. Although more accurate modeling is an obvious solution, it is often an impractical one. Model errors are here approximated by a white, Gaussian noise input, and its covariance (Q) is determined so as to produce consistency between residuals and their statistics. In this way, real-time feedback is provided from the residuals to the filter gain. Onset of divergence produces an increase in the filter gain and the adaptive filter is able to continue tracking. This scheme has a probabilistic interpretation. Under certain conditions the estimate of Q produces the most probable (finite) sequence of residuals. Author

N68-33828*# Analytical Mechanics Associates, Inc., Lanham, Md.
SUBOPTIMAL FILTERING. PART 2: COMPENSATION FOR MODELING ERRORS IN ORBIT DETERMINATION PROBLEMS Final Report
Andrew H. Jazwinski, Stanley F. Schmidt, Ann E. Bailie, and Norman Levine May 1968 48 p refs
(Contract NAS5-11048)
(NASA-CR-96578; Rept.-68-12, Pt. 2) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Fundamental characteristics of dynamic and measurement model errors in real time orbit determination systems are defined as errors in the equations of motion for the dynamic model, and errors in the computation of the estimated measurement for the measurement model. Two methods for deriving dynamic model compensation are discussed: introduction of pseudo-variables which cause the covariance matrix of errors in estimate to grow with time, and introduction of a nonoptimal filter which deliberately weights the most recent measurement heavier than that weighting obtained from optimal filter theory. Algorithms for processing data by the Kalman and weighted least squares produres are reviewed, and it is pointed out that the algorithms depend on both the type of filter and the method used in obtaining the dynamic model compensation. The use of acceptable error tolerance levels as a means of defining a model compensation scheme for processing batched data is considered. M.G.J.

N68-33829*# Analytical Mechanics Associates, Inc., Lanham, Md.
SUBOPTIMAL FILTERING. PART 3: LIMITED MEMORY OPTIMAL FILTERING Final Report
Andrew H. Jazwinski, Stanley F. Schmidt, Ann E. Bailie, and Norman Levine May 1968 13 p refs
(Contracts NAS5-11048; NAS5-9085)
(NASA-CR-96579; Rept.-68-12, Pt. 3) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Linear and nonlinear optimal filters with limited memory length are developed. The filter output is the conditional probability density function and, in the linear-Gaussian case, is the conditional mean and covariance matrix where the conditioning is only on a fixed amount of most recent data. This is related to maximum likelihood (least squares) estimation. These filters have application in problems where standard filters diverge due to dynamical model errors. This is demonstrated via numerical simulations. Author

N68-33904*# Systems Technology, Inc., Princeton, N. J.
NEW METHODS IN ADAPTIVE FLIGHT CONTROL
Lee Gregor Hofmann and John J. Best Washington NASA Sep. 1968 43 p refs
(Contract NAS1-6813)
(NASA-CR-1152) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A new approach to the design of adaptive control systems was developed. It is called the adaptive control function approach, and the systems so designed are called adaptive control function systems. This terminology is descriptive of the basic operating principle for these systems. The basic operating principle is that sums of properly modulated, conventional linear feedback and feedforward signals provide the control inputs needed to obtain specified responses in a number or output variables of a linear controlled element. The theoretical development in this report deals with linear, constant coefficient controlled elements only. With this restriction, the number of linearly independent controlled element responses which can be arbitrarily specified is equal to the number of independent control points. These specified responses then determine what the (ideal) control inputs should be. Author

N68-34095# Fluggerätewerk Bodensee G.m.b.H., Uberlingen (West Germany).
LABORATORY MEASUREMENTS ON AN INERTIAL PLATFORM SYSTEM [LABORMESSUNGEN AN EINER TRAGHEITSPLATTFORM-ANLAGE]
U. Krogmann, H. Tumback, H. Ricken, and H. Weilandt May 1968 63 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMWF-FBW-68-37) CFSTI: HC $3.00/MF $0.65

The described measurements refer to the testing of servo loops with undamped gyros. Prior to closed loop testing the phase- and frequency responses of the individual servo loops are determined in the open loop mode. Mechanical data are measured on the platform. In particular the alignment of the inertial sensors to each other is described. The possibility for measuring characteristical servo loop data by means of a special turntable is described. Author (ESRO)

N68-34160*# Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.
APPLICATIONS OF INERTIAL NAVIGATION AND MODERN CONTROL THEORY TO THE ALL WEATHER LANDING PROBLEM
Charles Broxmeyer, Duncan MacKinnon, and Paul Madden Jun. 1968 270 p refs
(Contract NAS12-602)
(NASA-CR-86098; R-613) CFSTI: HC $3.00/MF $0.65 CSCL 17G

This report investigates (a) the implications of inertial navigation for the automatic landing problem, and (b) the attainment of system performance criteria through the application of certain nonlinear control system techniques. A procedure based on estimation theory is developed for systematically correcting measured position and velocity data using Instrument Landing System radio beams as absolute references. The corrected inertial data provides the basis for the design of improved lateral and vertical position control systems. Additional improvements to the control system design are achieved by the addition of nonlinear reference flight path generation (utilizing the theory of optimal control) and simultaneous control of several reference variables. It is shown, by comparison with conventional systems, that the above design concepts yield improved response characteristics and minimize the sensitivity to external disturbances. In addition to the lateral and vertical channel control problems, the flareout and decrab control problems have been considered. Author

N68-34162# Fluggerätewerk Bodensee G.m.b.H., Uberlingen (West Germany).
DESIGN OF THE SERVO LOOPS FOR STABILIZATION OF A PLATFORM WITH GAS BEARING INTEGRATING GYROS AS SENSORS [AUSLEGUNG DER SERVOKREISE ZUR STABILISIERUNG EINER PLATTFORM MIT GASGELAGERTEN INTEGRATIONSKREISELN ALS MESSFUHLER]
U. Krogmann May 1968 47 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMWF-FBW-68-34) CFSTI: HC $3.00/MF $0.65

The servo-loop for stabilization of a single-axis platform is analyzed. Stabilization can be accomplished by a passive network with real poles and zeros or by an active network with conjugate complex zeros. Finally, comparison of the system with the different types of networks clearly shows the advantages of active compensation techniques. Author (ESRO)

N68-34748# Pickard and Burns Electronics, Waltham, Mass.
VLF AIRBORNE SYSTEM NOISE AND ANTENNA STUDY AND STUDY OF LANE IDENTIFICATION FOR OMEGA, VOLUME 2 Final Report
Richard H. Woodward, Morton F. Spears, Bernard Ambroseno, and David Davidson Mar. 1968 369 p
(Contract FA-65-WA-1298)
(P+B Publ.-979-8, V. 2; SRDS-RD-68-17) CFSDI: HC $3.00/MF $0.65)

Summaries of project meetings are presented in which technical and management problems were discussed between representatives of the contractor and various government agencies, chiefly the Federal Aviation Agency. Schedules and network/milestone charts the VLF airborne system noise and antenna study of lane identification for the Omega system as prepared for July of 1965 and August 1966 are shown. The remainder of this volume consists of graphs showing the Omega phase difference and field intensity patterns as observed at the various Omega stations in the United States and abroad. K.W.

N68-34780*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
IRRADIATION AND MANUAL NAVIGATION
Richard F. Haines and William H. Allen [1968] 19 p refs Presented at the 24th Ann. Inst. of Navigation Meeting, Monterey, Calif., 19-21 Jun. 1968
(NASA-TM-X-61190) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The irradiation phenomenon has the effect of displacing the apparent edge between a bright area and a darker area toward the latter. One method of quantifying this effect is by determining the minimal angle of resolution (MAR) between a point source and an extended bright source. This paper presents the results of a series of investigations on the MAR between a point and an extended circular source and between a point source and a simulated horizon. A total of 11 highly trained male observers took part in the studies

reported here. All had 20:20 distance acuity. Each observer moved a point source along various frontal plane meridians behind an extended source in order to determine at what position it became invisible due to the effects of irradiation. Results indicated that (1) the apparent edge of high luminance targets can be displaced as much as 15' arc from the target's actual edge under some viewing conditions, (2) the MAR is a function of the contrast ratio between the target and background and the luminance of the point source, and (3) the detrimental effects of irradiation are not reduced by using optical filters across the entire field of view to reduce the luminance of the extended source. The findings are related to certain aspects of manual navigation presently in use. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N68-33891 Northwestern Univ., Evanston, Ill.
AN ANALYTICAL STUDY OF THERMAL NEUTRON SPECTRA IN TWO DIMENSIONAL HOMOGENEOUS REACTOR CELLS
John David Luoma (Ph.D. Thesis) 1967 190 p
Available from Univ. Microfilms: HC $8.60/Microfilm $3.00 Order No. 67-15280

The space-energy dependent scalar flux is determined analytically for epithermal and thermal neutrons in a reactor consisting of a hexagonal lattice of coolant holes in a homogeneous mixture of fuel and moderator. All media are treated as a monatomic gas with respect to elastic scattering. The microscopic absorption cross section is taken to be inversely proportional to the neutron speed. The scalar flux is represented radially by modified Bessel functions ranging in order from zero to 60, azimuthally by a summation over cosines, and energetically by polynomials and negative exponentials. For the fuel-moderator mixture, U-235 and C-12, and coolant, H-1, the spectra are found to peak around .4kT, fall then rise between 1.2kT and 3kT, and decrease after 3kT. For low energies and small angles, the scaler flux radially increases in the fuel-moderator mixture; at higher energies, the flux decreases. Dissert. Abstr.

N68-33897# Atomic Energy Commission Research Establishment, Riso (Denmark). Electronics Dept.
BASIC RELIABILITY CONSIDERATIONS OF REACTOR INSTRUMENTATIONS [FORELAESNINGER OVER PALIDELIGHED AF REAKTORINSTRUMENTERINGER]
P. Timmermann Mar. 1968 16 p refs In DANISH
(RISO-M-722) CFSTI: HC $3.00/MF $0.65

Fundamental concepts for the instrumentation of nuclear reactors for reliable and safe operation are discussed, including control and safety equipment, redundant instrumentation, the fail-safe principle, electronic circuit reliability, and general system techniques. Detector applications, the measurement of neutron flux, and control rod operations are described. Basic requirements for the construction and functioning of safety equipment are outlined. Transl. by K.W.

N68-33949# Japan Atomic Energy Research Inst., Tokyo.
THE EFFECTIVE RESONANCE INTEGRAL OF THORIUM OXIDE IN HOMOGENEOUS MIXTURE
Makoto Obu Jun. 1968 8 p refs
(JAERI-1160) CFSTI: HC $3.00/MF $0.65

The effective Th^{232} resonance capture integrals were measured for homogeneous mixtures containing thorium oxide using the activation technique. Experiments were made in the blanket region with a thorium oxide-heavy water slurry in the Aqueous Homogeneous Critical Facility (AHCF). In the blanket, the slurry was circulated with a circulation pump so that the concentration distribution was uniform. A correction was calculated for the deviation of the epithermal neutron flux from the 1/E distribution. The resonance integrals of the homogeneous dilution were found for the scattering cross section in the range 160 ~ 4400 (10^{-24} cm^2) per absorbing atom. Author

N68-33991# Atomic Energy Commission Research Establishment, Risö (Denmark). Reactor Physics Dept.
DESCRIPTION OF THE URU-PROGRAMME
P. L. Olgaard Jan. 1968 49 p refs
(RISO-M-684) CFSTI: HC $3.00/MF $0.65

The URU-program (Utilization in Reactors of Uranium) was prepared to allow an assessment of the natural uranium consumption of different types of uranium fuelled thermal reactors, i.e. non-breeders. In the first part of the program the number of MW_ed, the Pu-production and the amount of remaining U, all per t nat. U, are calculated. In the second part the integrated uranium consumption and plutonium production are calculated as functions of time for a system of reactors of a given type and with specified total capacity and power production. The cases of no recycling, of uranium cycling only and of plutonium and uranium recycling are considered. The report contains a derivation of the formulas used, instructions for the use of the programme, a print-out of the program, and a test example. Author

N68-34087*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY STUDY OF A THERMIONIC REACTOR CORE COMPOSED OF SHORT-LENGTH EXTERNALLY FUELED DIODES
Howard G. Yacobucci Washington Sep. 1968 69 p refs
(NASA-TN-D-4805) CFSTI: HC $3.00/MF $0.65 CSCL 18I

The characteristics of a thermionic reactor-core concept, aimed at incorporation of the best features of several previously proposed concepts, are studied. Optimization of diode dimensions resulted in a reference design for a 211-kW electric core. The design, which employs electrical zoning to reduce the detrimental effect of radial thermal power variation, was analyzed for various electrical failures. Equations were derived for calculating internal resistance losses in diodes that have an electrical conductor in parallel with an electrode. Author

N68-34107# Aktiebolaget Atomenergi, Stockholm (Sweden).
STABILITY OF A STEAM COOLED FAST POWER REACTOR, ITS TRANSIENTS DUE TO MODERATE PERTURBATIONS AND ACCIDENTS
Heinz Vollmer May 1968 36 p refs
(AE-321) CFSTI: HC $3.00/MF $0.65

The dynamic behavior of a steam cooled fast power reactor is investigated with respect to stability, transients due to moderate perturbations at the operating point, and accidents. The studies were performed for a direct cycle, integral plant design for different system pressures, component arrangements and component designs. The stability domain of such a plant is found to be mainly determined by pressure, fuel temperature and coolant density coefficients of reactivity. Other design parameters are of minor influence on stability. The plant is load-following and displays acceptable performance if the reactivity coefficients are not too close to their limiting values. If they are, effective controllers can be designed which ensure good plant operation. The consequences of accidents may be limited by proper design and adequate counteraction. Author (ESRO)

N68-34108# Aktiebolaget Atomenergi, Stockholm (Sweden).
A STUDY OF THE TEMPERATURE DISTRIBUTION IN UO_2 REACTOR FUEL ELEMENTS
I. Devold May 1968 84 p refs
(AE-318) CFSTI: HC$3.00/MF$0.65

Thermal conductivity is one of the most important properties of nuclear reactor fuels. Accurate knowledge of this property is vital because, among other things, it determines the maximum power that can be taken out of the fuel element per unit length of the material without exceeding the safety limits of the fuel elements. This report consists of a study of the thermal behavior of uranium dioxide in the form of reactor fuel. The experimental part of the report describes measurements performed at the OECD Halden Reactor Project, Halden, Norway. The experiment was originally set up in order to measure the temperature at the center of a UO_2 fuel element as a function of element power, in order to determine the safe operation limit of the fuel assembly. However, in analyzing the data obtained, very interesting thermal conductivity values were obtained and comparison with existing correlations could be performed. This comparison shows that a certain agreement is obtained between the measured data at Halden and a theory published by J. L. Bates in 1961, which predicts an increase in the thermal conductivity above 1500°C. The data obtained below 1300°C are also in good agreement with measurements performed by Vogt, Grandell and Runfors in 1964. The report contains a mathematical description of the heat transfer mechanisms in cylindrical fuel elements. The model is coded in FORTRAN IV-code and referred to as FUELTEMP. Author (ESRO)

N68-34147# Dow Chemical Co., Golden, Colo. Rocky Flats Div.
EFFECTS OF SPATIAL RESOLUTION ON CRITICAL MASS CALCULATIONS
Donald C. Coonfield and Douglas C. Hunt. 31 May 1968 8 p refs
(Contract AT(29-1)-1106)
(RFP-1133) CFSTI: HC$3.00/MF$0.65

A systematic study is presented of the effects of spatial resolution on critical mass calculations. The critical assemblies considered were reflected and moderated uranium–metal systems. The calculations were done by varying the spatial mesh in the transport-theory, Computer Code DTF II. The results are compared with experimentally measured critical masses. The conclusion is that proper handling of spatial resolution in these types of critical systems can significantly improve the agreement between theory and experiment. Author (NSA)

N68-34152# Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center.
LIQUID METAL TEMPERATURE MEASUREMENT (SODIUM) STATE OF THE ART STUDY
J. S. Hochheiser 31 May 1968 98 p refs
(Contract AT(04-3)-700)
(LMEC-MEMO-68-10) CFSTI: HC$3.00/MF$0.65

A study of the available techniques and devices for making temperature measurements applicable to liquid sodium cooled nuclear power reactors is presented. Included in this study is a review of the calibration and standards accuracies available, a study of the behavior of matter with temperature and with exposure to liquid metal reactor environments, and a literature survey. A review of the fundamentals of temperature of and temperature measurement theory and a list of definitions are included. Author (NSA)

N68-34304# Battelle Memorial Inst., Richland, Wash. Pacific Northwest Lab.
RECENT ADVANCES IN REGENERATIVE IN-CORE NEUTRON FLUX MONITORS
Charles N. Jackson, Jr. 31 May 1968 16 p refs
(Contract AT(45-1)-1800)
(BNWL-SA-1621(REV.)) CFSTI: HC$3.00/MF$0.65

Recent investigations in the development of regenerating flux monitors, a novel detector concept that employs a mixture of fertile and fissile uranium isotopes (90% ^{234}U–10% ^{235}U), are reported. In this coating material ^{234}U transmutes by thermal neutron absorption to ^{235}U replacing similar atoms lost due to burnout thereby accomplishing the regenerating function and extending the useful life of the neutron sensor. In-core irradiation tests at the ETR are summarized. NSA

N68-34335# Battelle Memorial Inst., Richland, Wash.
CRITICAL EXPERIMENTS WITH HOMOGENEOUS PuO_2 POLYSTYRENE AT 5H: Pu
S. R. Bierman, L. E. Hansen, R. C. Lloyd, and E. D. Clayton 21 May 1968 13 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto, Ontario
(Contract AT(45-1)-1830)
(BNWL-SA-1630; CONF-680601-18) CFSTI: HC$3.00/MF$0.65

Criticality parameters for mixtures of fuel having an 11.5 wt% ^{240}Pu isotopic concentration and an atomic H/Pu ratio of 5 are presented. Experimental data are obtained from both bare and reflected rectangular parallelepipeds of PuO_2–polystyrene fuel. NSA

N68-34359# European Atomic Energy Community, Ispra (Italy).
BEHAVIOUR OF URANIUM CARBIDE FUEL RODS SAP CLADDED: THEORETICAL STUDY [COMPORTEMENT DES CRAYONS COMBUSTIBLES DE CARBURE D'URANIUM GAINES DE SAP: ETUDE THEORIQUE]
J. C. Charrault, M. Fantozzi, and B. Huber Brussels Jun. 1968 87 p refs In FRENCH; ENGLISH summary
(EUR-4031.f) CFSTI: HC$3.00/MF$0.65

The behaviour of uranium carbide fuel rods cladded SAP (Sintered Aluminum Powder) in the reactor has been given a mathematical formulation programmed on the 360 IBM computer, under the name of code CRAYON. Two versions are now available of this code: CRAYON G1 for rods having a gas bonding between fuel and cladding, and CRAYON L1 for rods having a liquid bonding. This document describes the principal results drawn from the application of the two versions of this code. These results appear mainly in the form of fuel burn-up at clad rupture, in function of the different operational and manufacturing parameters. Author

N68-34360# Societe Belge Pour l'Industrie Nucleaire, Brussels (Belgium).
HEAT TRANSFER IN NUCLEAR FUELS MADE FROM URANIUM DIOXIDE AND URANIUM DIOXIDE–PLUTONIUM DIOXIDE COMPACTED POWDERS [TRANSFERT DE CHALEUR A L'INTERIEUR DE COMBUSTIBLES NUCLEAIRES CONSTITUES DE POUDRES COMPACTEES D'UO SUB 2 ET D'UO SUB 2-PUO SUB2]
H. Andriessen EURATOM Jun. 1968 52 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-001-64-1 TRUB)
(EURAEC-1998; EUR-3791.f) CFSTI: HC$3.00/MF$0.65

The $\int$ kdT curve of fuels consisting of vibratory compacted UO_2 and UO_2-PuO_2 powders was measured out of pile as a function of the temperature. The influence of the helium, argon, and nitrogen filler gases on the value of $\int$ kdT was measured and the Deissler and Eian theory was used to evaluate the properties of the thermal conductivity of the ceramic material and the gas at the measured total values of the thermal conductivity. The influences of the density and the presence of the PuO_2 on the $\int$ kdT value were evaluated. Author

N68-34381# European Atomic Energy Community, Karlsruhe (West Germany).
ISOTOPIC ANALYSIS OF IRRADIATED FUEL AND TRANSPLUTONIUM ELEMENTS. 1: OBJECTIVES AND METHODS
M. W. Geerlings and L. Koch Brussels Jun. 1968 29 p refs
(EUR-3949.e) CFSTI: HC$3.00/MF$0.65

The objectives and the usefulness of isotopic analyses are outlined, and the selected experimental methods are summerized. The analyses are a part of the post irradiation examination of reactor fuel and fuel elements, with the emphasis on plutonium containing materials. Major purpose is the determination of precise values, including spatial variations, of burnup as well as conversion of fissile and fertile nuclides. The formation of isotopes of transplutonium elements is also of interest. Author

N68-34395# General Electric Co., San Jose, Calif. Nuclear Fuels Dept.
FISSION GAS RELEASE FROM UO_2 IRRADIATED ISOTHERMALLY AT TEMPERATURES FROM 1500°C TO 2100°C
G. A. Esswein Mar. 1968 51 p refs
(Contract AT(04-3)-189)
(GEAP-5100-10; EURAEC-2034) CFSTI: HC$3.00/MF$0.65

Fission gas release data were obtained for sintered UO_2 from four capsules which contained fuel test specimens irradiated at nominal temperatures of 1500, 1700, 1900, and 2100°C under nearly isothermal conditions. The original purpose of these irradiations was to better define the temperature-release fraction relationship in the temperature range between 1500 and 2100°C. Within this critical temperature range, the fraction of the fission gas that is released increases from less than one percent to virtually complete release, even during short-term irradiations. A capsule design with several separate fuel regions was developed for the experiments to minimize the axial temperature gradient in the test fuel specimen and maintain its radial gradient at a low, predetermined value. The actual fission gas release data obtained from three of the four capsules were compromised by brittle fracture of the tungsten cladding that enclosed the UO_2 test specimens. However, the final test capsule design provided excellent operating conditions. Author (NSA)

N68-34403# Gesellschaft fuer Kernforschung M.B.H. Karlsruhe (West Germany). Inst. fuer Heisse Chemie.
BEHAVIOR OF HIGH PLUTONIUM CONCENTRATES IN THE PUREX PROCESS AND THE DEVELOPMENT OF FAST EXTRACTORS FOR RECONDITIONING OF NUCLEAR FUELS [DER VERHALTEN HOHER PLUTONIUMKONZENTRATIONEM IM PUREX-PROZESS UND DIE ENTWICKLUNG SCHNELLER EXTRAKTOREN ZUR WIEDERAUFARBEITUNG VON KERNBRENNSTOFFEN]
F. Baumgaertner, W. Ochsenfeld, B. Roth, and L. Finsterwalder Aug. 1967 30 p refs In GERMAN Supported jointly by the European Atomic Energy Community, Karlsruhe, West Ger. and Ges. fuer Kernforsch., Karlsruhe, West Ger.
(KFK-652; EUR-3683-d)

Discussed is the recessive extraction of plutonium from nuclear fuels with high plutonium content. A plutonium-uranylnitrate-tributylphosphate extraction system gave good results when the tributylphosphate concentration remained at 80% and when the organic material of the extraction phase was free of impurities. Extraction in accelerated and counterflowing centrifugal extractors eliminated possible criticality and radiolysis of the extracting materials. Transl. by G.G.

N68-34404# Gesellschaft fuer Kernforschung M.B.H., Karlsruhe (West Germany). Inst. fuer Heisse Chemie.
DISSOLVING OF BREEDER REACTOR FUELS CONTAINING PLUTONIUM DIOXIDE IN NITRIC ACID FOR AQUEOUS RECONDITIONING USING THE PUREX PROCESS [UEBER DIE AUFLOESUNG VON PuO_2-HALTIGEN BRUETERBRENNSTOFFEN IN SALTPETERSAEURE FUER DIE WAESSRIGE WIEDERAUFARBEITUNG NACH DEM PUREX-VERFAHREN]
W. Baehr and Th. Dippel Jul. 1967 22 p refs In GERMAN Supported jointly by European Atomic Energy Community, Karlsruhe, West Ger. and Ges. Fuer Kernforsch., Karlsruhe, West Ger.
(KFK-673; EUR-3704-d)

The solubility of plutonium oxide powder and sintered uranium oxide–plutonium oxide pellets in nitric acid was studied. It was shown that the reactor irradiated sintered fuel dissolved much faster than the sample plutonium oxide powder; uranium oxide–15% plutonium oxide pellets were completely dissolved in nitric acid after 8 hours at 1700°C. Transl. by G.G.

N68-34416# Technische Hogeschool, Eindhoven (Netherlands).
HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS OF A PRESSURIZED WATER REACTOR Final Report
Brussels EURATOM 1968 58 p refs
(Contract EURATOM-011-64-1 TEEN)
(EUR-3790.e; EURAEC-1997)

The research effort was aimed at the study of the heat transfer and fluid flow characteristics in pressurized water reactors. In this research program much attention was paid to mixing effects within and between parallel hydraulic channels. The activities during the first year were directed towards getting the 140-atmospheres pressurized water loop in operation. At the end of the first year the operational behavior from the point of view of water characteristics, scaling of the heating elements and adjustment of stable conditions even at low mass flows was very successful. The loop was then in such a condition that the experimental program proposed could be started. During the second year experimental work on mixing has been done in the pressurized loop. During the same period an air water test set up has been put in operation. This apparatus has been made available by the Division Atomique of SNECMA. During the final year experimental data have been obtained both from the pressurized water loop and the air water test set up. Author

N68-34460# Societe Belge Pour l'Industrie Nucleaire, Brussels (Belgium).
THERMAL BEHAVIOUR OF URANIUM AND PLUTONIUM OXIDE CERAMIC FUELS UNDER IRRADIATION AT HIGH SPECIFIC POWERS: INDICATIVE EXPERIMENTS [COMPORTEMENT THERMIQUE DE COMBUSTIBLES CERAMIQUES D'OXYDES D'URANIUM ET DE PLUTONIUM SOUS IRRADIATIONS A HAUTES PUISSANCES SPECIFIQUES: EXPERIENCES D'ORIENTATION]
A. Lhost. EURATOM Jun. 1968 94 p refs In FRENCH; ENGLISH summary
(Contract Euratom-001-64-1 TRUB)
(EURAEC-1999; EUR-3792.f)

A particular variant of the technique of vibratory compacting dense powders of uranium and plutonium oxides, consisting in the introduction of the latter only in the fine fraction (heterogenous rods), is developed. While out-of-pile studies have made it possible to evaluate the thermal conductivity of mixed UO_2 PuO_2 oxides and to obtain a first indication of the influence of the parameters (filler gas, density compacting methods, power rating, etc.), it was necessary to confirm these results by irradiation tests. These tests were carried out in the BR-2 using different types of power run-up. The present work consists of tests for the orientation of the program during which the main parameter is the linear heat rating which has varied from 140 to 1500 W/cm. The main conclusions drawn from the present study are that the peripheral distribution of the PuO_2 has a beneficial influence on the central temperature of the rod, and that the power heterogeneities are twice as great as those of the gamma activity at 384 keV measured before irradiation. Author

N68-34470# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Inst. Teoreticheskoi i Eksperimental'noi Fiziki.

SOME PROBLEMS IN REGARD TO THE HETEROGENEOUS THEORY FOR A REACTOR [NEKOTORYE ZADACHI GETEROGENNOI TEORII REAKTORA]

A. D. Galanin 1967 39 p refs In RUSSIAN; ENGLISH summary (ITEF-563)

General heterogeneous equations for a reactor with the reflector of the same properties as the moderator in the reactor are formulated in two-group approximations. It is supposed that the distance between fuel elements is much larger than the scattering length in the moderator. In the diffusion approximation, the kind of boundary conditions at the surface of each fuel element is established. The following questions are considered: the length of migration in the direction of the axes of fuel elements; critical conditions and mutual block-effect for the double lattice; reactor inhomogeneous in height; and length of migration in the direction normal to the axis of fuel elements. Author (NSA)

N68-34474# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

SURVEY OF HYDRAULIC MODELING EXPERIENCE FOR REACTOR CORE SYSTEMS

K. D. Hayden Aug. 1967 51 p refs

(Contract AT(45-1)-1830)

(BNWL-518(Del.)) CFSTI: HC $3.00/MF $0.65

The fluid-flow system of the Fast Flux Test Facility reactor core is analyzed. Model studies of the reactor vessel and core system are discussed. Lists of nine selected reactor sites, reactor types, model size and experimental studies conducted for design support are presented. NSA

N68-34476# Argonne National Lab., Ill.

STUDY OF THE OPERATION OF AN ASSEMBLY OF FUEL ELEMENTS CONTAINING PLUTONIUM DIOXIDE FUEL IN THE BR-5 REACTOR [ISSLEDOVANIE RABOCHEGO PAKETA TVELOV REAKTORA BR-5 S GORYNCHIN IZ DVUOKISI PLUTONIYA]

O. D. Kazachkovskii, S. N. Votinov, I. G. Lebedev, V. I. Kuz'min, V. N. Syuzev et al May 1968 12 p refs Transl. into ENGLISH from At. Energ. USSR (Moscow), v. 24, no. 2, Feb. 1968 p 136–143

(ANL-TRANS-609) CFSTI: HC $3.00/MF $0.65

Dimensional changes, fission gas production, metallurgical structure changes, and mechanical property changes were studied for a stainless steel-clad PuO_2 fuel element assembly irradiated to 6.1% burnup in the BR-5. NSA

N68-34481# Westinghouse Electric Corp., Lima, Ohio.

ELECTRICAL COMPONENT TECHNOLOGY FOR 1/4 TO 10 MEGAWATT SPACE POWER

A. E. King, J. B. Fanger, and G. S. Leighton (AEC, Washington, D. C.) Aug. 1968 13 p refs Presented at 3d Ann. Intersoc. Energy Conversion Eng. Conf., Boulder, Colo., 13–16 Aug. 1968

(Contract AT(04-3)-674)

(CONF-680802-1) CFSTI: HC $3.00/MF $0.65

Analytical data are presented for electrical power system components in advanced high-temperature, postasium Rankine nuclear space power systems. Power level and coolant temperature were used as independent variables to define combined minimum weight, maximum efficiency configurations based on an extensive background in the development of high temperature electrical materials, ac generators and motors, and power conditioning equipment for space applications. The data presented forecast electrical power system component design limitations and envelopes of minimum weight designs relative to such major systems parameters as temperature, shaft speed, voltage and frequency. Representative missions were analyzed for purposes of defining the ranges and types of electrical power needs and corresponding components. Author (NSA)

N68-34512# Los Alamos Scientific Lab., N. Mex.

LAMPF CONTROL PHILOSOPHY

Raymond A. Gore 1968 4 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y.

(Contract W-7405-eng-36)

(LA-DC-9436; CONF-680515-9) CFSTI: HC $3.00/MF $0.65

The basic areas of control are defined, followed by brief descriptions of the various operating systems and a discussion of the basic approach to the computer control of the LAMPF accelerator. Also, results of a computer control of the electron prototype accelerator, planned as a mockup of the LAMPF accelerator, are presented. NSA

N68-34562# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Reaktorbauelemente.

ON THE EVOLUTION OF A COMPLETELY HYDRAULIC DRIVEN AND CONTROLLED CONTROL AND SHUT-OFF SYSTEM FOR WATER OF STEAM COOLED NUCLEAR REACTORS [ZURENTWICKLUNG EINES VOLLHYDRAULISCH BETRIEBENEN UND GESTEURTEN REGELUND ABSCHALTSYSTEMS FUER WASSER-BZW. DAMPFGEKUEHLTE KERNREAKTOREN]

O. Muehlhaeuser Nov. 1967 40 p refs In GERMAN Supported in part by European Atomic Energy Community, Karlsruhe, West Ger.

(KFK-665; EUR-3699-d)

A general discussion of the development of completely hydraulic drives for control rods is given. The various components are described; these are: a hydraulic reciprocating motor for the control rod, a hydraulic potentiometer, automatic control devices, servo-piston, rachet brake, position recorder, cut-off valve, and recovery and damping springs. Schematics of the components and systems are shown. NSA

N68-34578# Atomics International, Canoga Park, Calif.

SNAP 2 DEVELOPMENTAL REACTOR MOCKUP NO. 1 Final Report

L. Maki and J. F. Milner 15 Jun. 1968 53 p

(Contract AT(11-1)-GEN-8)

(NAA-SR-12186) CFSTI: HC $3.00/MF $0.65

The acceptance level, shock, vibration, NaK loading, and thermal-vacuum operational tests demonstrated that the S2DRM-1 reactor assembly can survive the non-nuclear environments that would be imposed upon it from final assembly through start-up and 20 days of operation at temperature in a vacuum (simulating an earth orbit) without failure. The thermal-vacuum operational test was terminated (after 20 days) due to the failure of the NaK heater assembly, which was not part of the reactor system. Comparison of the performance record test data taken prior to and after each phase of testing showed no signs of degradation of the reactor assembly components. A 30-element NaK heater and reservoir assembly was designed and fabricated for testing at elevated temperatures up to 1450°F. SNAP 10A flight-type motors (with mounting adapters) and controller were used to rotate the fine control drums during the tests. The SNAP 10A motors and controller demonstrated their compatibility with the SNAP 2 reflector assembly. The vacuum chamber pressure obtained using the titanium sublimation and ion pumping system (UHV) system during thermal-vacuum testing of the S2DRM-1 reactor system substantiated the pre-test information. A preliminary pumpdown of the modified vacuum chamber was conducted prior to installing the reactor system. An ultimate pressure of 5×10^{-10} torr was obtained in the clean, dry, and empty chamber without bakeout. Preliminary test results indicate that there was insufficient developmental testing of the UHV system prior to its use in testing the S2DRM-1 reactor system. Author (NSA)

N68-34580# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
GRAPHITE IRRADIATIONS IN EBR-2: CAPSULES BG-1, BG-2, AND BG-3
A. L. Pitner May 1968 20 p refs
(Contract AT(45-1)-1830)
(BNWL-740) CFSTI: HC $3.00/MF $0.65

Nine grades of graphite were irradiated in the EBR-II reactor from 400° to 700°C to maximum exposures of 8×10^{21} nvt (E < 0.18 MeV). Three isotropic graphites showed good dimensional stability in the irradiations. Apparently, there is no adverse difference in the behavior of graphite irradiated in fast or intermediate reactors. The excellent agreement obtained between exposure calculated from the activation of nickel and iron flux monitors attests to the accuracy of the monitor cross sections and calculated neutron spectrum employed in determining the exposures. Author (NSA)

N68-34596# Atomics International, Canoga Park, Calif.
NEW CROSS SECTION NEEDS FOR ZIRCONIUM HYDRIDE SNAP REACTORS
Eric Ottewitte 2 Apr. 1968 12 p Presented at 2d Conf. on Neutron Cross Sect. and Technol., Washington
(Contract AT(04-3)-701)
(AI-AEC-MEMO-12673; CONF-680307-35) CFSTI: HC $3.00/MF $0.65

A zirconium hydride SNAP reactor consists of hydrided rods of U–Zr alloy surrounded by rotatable beryllium reflector drums. The current direction of SNAP reactor designs is toward reliable long-term (1 to 5 years) operation and additional safety features. These designs may require poison-backings on the reflector drums (for some applications) plus a variety of new burnable poisons. Candidate poison-backings include europium and other rare earths as well as B_4C. Both absorption and scattering cross sections are important, particularly in the keV range. Candidate burnable poisons include Gd-157, Sm-149, Cd-113, Gd-155, Hf-177, Ir-191, Eu-151, Dy-162, Sm-152, and Dy-163. The absorption cross sections below 10 eV are particularly important. One of the desired safety features in future zirconium hydride reactors is subcriticality in water in the event of a launch abort. This might be achieved through spectral shift if the burnable poison has a low-lying (below 1.1 eV) resonance. A large number of stable or long-lived isotopes which have not been measured for low-lying resonances are indicated. Author (NSA)

N68-34598# Los Alamos Scientific Lab., N. Mex.
THE METALLOGRAPHIC PREPARATION AND MICROSCOPIC EXAMINATION OF A MOLYBDENUM URANIUM DIOXIDE CERMET FUEL
D. R. Schuyler and T. G. Gregory [1968] 22 p refs Presented at 22d AEC Met. Group Meeting, San Diego, Calif.
(Contract W-7405-eng-36)
(LA-DC-9618; CONF-680614-2) CFSTI: HC $3.00/MF $0.65

A procedure for the metallographic preparation of tungsten-coated Mo–UO_2 cermet fuels was developed specifically for their subsequent examination by replica electron microscopy. Both polishing and etching procedures were evaluated as well as replication techniques for electron microscopy. The best polishing techniques involved the use of an alumina–chromic acid slurry on rotating cloth laps. Etching of the UO_2, as well as other portions of the material, could be accomplished with a variety of etchants that would affect only specific structures. Examination of the prepared surface by replica electron microscopy could reveal fission product voids down to 100 Å in diameter. Author (NSA)

N68-34613# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
FABRICATION OF RESEARCH REACTOR FUEL ELEMENTS
G. M. Adamson, Jr. Jun. 1968 25 p ref Presented at the AEC Ind. Meeting, Water Reactor Fuel Element Technol., Washington, D. C., 29–30 Jan. 1968
(Contract W-7405-eng-26)
(ORNL-TM-2197; CONF-680114-1) CFSTI: HC $3.00/MF $0.65

A discussion is presented on the fabrication techniques used to fabricate fuel elements for research reactors. Such fuel elements are aluminum base with fuels of either uranium–aluminum alloy or dispersions of powered U_3O_8 or UAl_3 in aluminum powder. Emphasis is on the latter types which are the ones used in the advanced high performance reactors such as HFIR and ATR. The primary operation or design problem affecting fabrication is control of hot spots. This requires close control of uranium loading and distribution, core thickness, quality of bonds, absence of blisters, and uniform water-channel thickness. Control of each factor is discussed. The fabrication of the dispersion plates is divided into the following areas: powder preparation, core fabrication, plate rolling, and inspection. Techniques for both U_3O_8 and UAl_3 are presented. Assembly operations are included for elements joined both by the mechanical roll swaging technique and by welding. The latter represents the technique now being used to fabricate the HFIR elements. Author (NSA)

N68-34617# Oak Ridge National Lab., Tenn.
NUCLEAR DESALINATION PROGRAM: FLYWHEEL-AUGMENTED FLOW COASTDOWN FOR THE 3500 MWT, UNCLAD, METAL-FUELED FBR (UMBR)
R. P. Wichner Jul. 1968 37 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2132) CFSTI: HC $3.00/MF $0.65

Equations are presented for the coastdown flowrate in a loop following pump power failure which include the effects of diminishing pump efficiency during coastdown and the retarding torque of the thrust bearings on the pump rotation rate. The bearings are assumed to be of the Kingsbury type with eight, square shoes. Results are given for the primary coolant loop of the 3500 MW(t), sodium-cooled, bare-metal, FBR, for cases utilizing light weight (15,000 kg), medium (60,000 kg), and heavy (240,000 kg) flywheels with 6 m diameter. It is shown that the useful coastdown duration lasts 15 seconds with no added flywheel, and about a factor of 30 increase is attained by adding the light flywheel to each of the primary pump motors. The medium weight flywheels could increase the useful coastdown duration to 2100 seconds, while the heavy flywheels resulted in coastdowns ranging from 6000 seconds to 8100 seconds, depending on the bearing design. Author (NSA)

N68-34621# Los Alamos Scientific Lab., N. Mex.
LARGE PARTICLES IN THE PHOEBUS 1B EFFLUENT
Robert V. Fultyn 17 Jun. 1968 26 p refs
(Contract W-7405-eng-36)
(LA-3796-MS) CFSTI: HC $3.00/MF $0.65

The efforts directed toward collecting and examining the large particles released by the Phoebus 1 B reactor are described. Successful and unsuccessful collections and evaluation techniques are discussed in detail. Results show that all physical characteristics must be described statistically as variate quantities. Author (NSA)

N68-34637# TRW Equipment Labs., Cleveland, Ohio.
CORROSION PRODUCTS IN THE SNAP 2/MRPCP CRU V TEST SYSTEM
R. C. Schulze and E. T. Vargo [1968] 144 p refs *Its* Topical Rept. no. 35
(Contract AT(04-3)-690)
(TRW-690-33; TRW-ER-7253) CFSTI: HC $3.00/MF $0.65

The results of a study of the Hg corrosion product problem in the MRP/SNAP 2 system are presented and discussed. It was established in this study that the primary source of corrosion products in the system Hg was the boiler. High quality Hg vapor must be maintained in order to prevent the introduction of an inordinate amount of corrosion products into the turboalternator (CRU V) by liquid carryover. Spectrographic analysis of hot Hg samples taken during operation was used to monitor the corrosion product level. Upon startup of a test the corrosion product level in the system Hg is relatively high. However, steady state operation soon produces a very low level of corrosion products in the liquid Hg. Careful control of system materials, vacuum integrity and cleanliness significantly reduce the corrosion product burden. The characteristics of the corrosion product deposition in the vapor regions of the system vary from those found in the liquid region. The deposits in the former were metallic (Cr, Ni, Fe, and Co) and those which deposited in the liquid section were present as spinels (Fe_2O_3 and Me_3O_4). Electron microscopy, electron diffraction and electron beam microprobe techniques were used to evaluate the corrosion and corrosion products. Author (NSA)

N68-34709# Argonne National Lab., Ill.
REACTOR DEVELOPMENT PROGRAM
Jul. 1968 148 p refs
(Contract W-31-109-eng-38)
(ANL-7457) CFSTI: HC $3.00/MF $0.65

This monthly progress report includes information on EBWR, LMFBR, ZPR-3, ZPR-6, ZPR-9, ZPPR, EBR-II, general reactor technology, and reactor safety including TREAT operations. For detailed information, see the annual reports from the following ANL Divisions: Chemical Engineering, Metallurgy, Reactor Engineering, and Reactor Physics. NSA

N68-34736# Sandia Corp., Albuquerque, N. Mex.
SAMARIA-TUNGSTEN CERMET IMPACT TESTS
B. S. Hill Jun. 1968 38 p Sponsored by AEC
(SC-DR-68-295) CFSTI: HC $3.00/MF $0.65

Two samaria–tungsten cermets were impact tested on granite at 200 and 250 fps. The cermets comprised SmO_2 microspheres coated by chemical vapor deposition with 20 vol % W and encapsulated in W–25 Re clad. Dummy capsules containing hot-pressed Sm_2O_3 were also tested. Metallographic analysis and visual observation showed only slight cracking of the capsule and no gross failure of the cermet. NSA

N68-34737*# General Electric Co., Pleasanton, Calif. Nuclear Thermionic Power Operation.
MULTIMEGAWATT THERMIONIC REACTOR SYSTEMS FOR SPACE APPLICATIONS
C. D. Sawyer, P. R. Hill, and D. R. Wilkins [1968] 13 p refs Presented at the 2nd Intern. Conf. on Thermionic Elec. Power Generation, Stresa, Italy Sponsored by NASA and AEC
(NASA-CR-96782; CONF-680508-2) CFSTI: HC $3.00/MF $0.65 CSCL 18N

A review of selected portions of the General Electric Company thermionic reactor development program is presented. Typical design features and performance characteristics of thermionic reactors with electrical ratings in the multimegawatt class are presented by reference to the results of a reactor design study carried out for a hybrid nuclear rocket/nuclear electric Mars mission. Important elements of related technology from other elements of the General Electric program are also presented. In particular, a summary of the results of a thermionic reactor critical experiment and the results of preliminary reactor stability studies is discussed. Author (NSA)

N68-34747# Minnesota Mining and Mfg. Co., St. Paul, Minn. Electrical Products Group.
SNAP-23A PROGRAM. PHASE 1: THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM Quarterly Report, 1 Jan.–31 Mar. 1968
J. V. Wachenheim 31 Mar. 1968 152 p
(Contract AT(30-1)-3824)
(MMM-3824-0020; QR-5) CFSTI: HC $3.00/MF $0.65

During the quarter, fabrication of Experimental Mockup Converters (EMC's) Nos. 2 and 3 was completed; EMC No. 1 was integrated into EMS No. 1; EMC No. 2 completed short-term testing and successfully underwent dynamic testing; and EMC No. 3 completed short-term testing. Experimental Mockup Converter No. 3 has been modified which resulted in improved power output, efficiency, and heat transfer characteristics. These modifications consisted of changing the basic thermocouple design configuration to include bonded type P-legs (rather than the simultaneously pressed P-legs used in EMC Nos. 1 and 2), and addition of indium foil at the cold cap-to-follower spherical interface to reduce the temperature differential. Analysis of data from tests conducted up to this time indicates that the converter performance is significantly better than EMC Nos. 1 and 2 (7.43% overall efficiency at EOL conditions for EMC No. 3 as opposed to 7.0% for EMC No. 2). Author (NSA)

N68-34755# Oak Ridge National Lab., Tenn.
THE HIGH-FLUX ISOTOPE REACTOR: A FUNCTIONAL DESCRIPTION. VOLUME 1B. ILLUSTRATIONS
F. T. Binford, ed. and E. N. Cramer, ed. Jun. 1968 174 p refs
(Contract W7405-eng-26)
(ORNL-3572, Rev. 2, V. 1B) CFSTI: HC $3.00/MF $0.65

Diagrams and drawings of the HFIR site, buildings, reactor, auxiliary facilities, and reactor components, systems, and instruments are presented. NSA

N68-34767# Phillips Petroleum Co., Idaho Falls, Idaho.
ENGINEERING AND TEST BRANCH Quarterly Technical Report, 1 Oct.–31 Dec. 1967
K. A. Dietz, ed. May 1968 75 p refs
(Contract AT(10-1)-205)
(IDO-17242) CFSTI: HC $3.00/MF $0.65

Continued research in the following areas is reported: reactor safety, reactor fuel elements; decontamination; reactor containment structures; fission products; heat transfer; and coolant loss accidents in and thermal transient behavior of water cooled reactors. NSA

N68-34781# Douglas United Nuclear, Inc., Richland, Wash.
THE APPLICATION OF THE HAMMER COMPUTER CODE TO EX-REACTOR CRITICALITY CALCULATIONS
R. A. Chitwood 3 May 1968 23 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto, Ontario
(Contract AT(45-1)-1857)
(DUN-SA-69; CONF-680601-19) CFSTI: HC $3.00/MF $0.65

Comparisons between calculated results using the HAMMER computer code and experimental data for a number of water-moderated, low enrichment systems are presented. Designs represent typical fuel geometries for the New Production Reactor. Calculations presented include: material buckling in water of discharged NPR fuel as a function of exposure; and criticality safety of a fuel shipping cask. NSA

N68-34782# Douglas United Nuclear, Inc., Richland, Wash.
CALCULATIONS OF PHYSICS PARAMETERS FOR MIXED FUEL-TARGET LATTICES
L. J. Agee 22 May 1968 26 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto, Ontario
(Contract AT(45-1)-1857)
(DUN-SA-70; CONF-680601-17) CFSTI: HC $3.00/MF $0.65

Methods and combinations of computer programs for predicting known lattice physics parameters are described. All the different methods of analysis are correlated with the results of four representative tests performed in the Physical Constants Testing Reactor. NSA

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N68-33613 National Lending Library for Science and Technology, Boston Spa (England).
SIGNAL ANALYSIS BY NUMERICAL TECHNIQUE
A. Castanet 5 Dec. 1967 8 p Transl. into ENGLISH from Onde Electrique (France), v. 46, no. 475, Oct. 1966 p 1117-1120 Presented at the Conf. on Contrib. of Electron. to the Statist. Treat. of Phys. Meas., Grenoble, 26-29 Apr. 1966 *Its* Transl. 2429
Available from Natl. Lending Library, Boston Spa, Engl.

Described are specialized numerical and/or automatic devices for analyzing signals which are under development or in operation. The devices were designed to increase accuracy of collecting, recording, reading, editing, sampling, storing, and measuring data on signals of large dynamic range and wide band which will be subsequently stored in a general purpose computer. Devices under development include: (1) sampling and collecting equipment to provide for synchronization of different peripheral equipment for the digital to analog conversion of short signals (less than 50 ms); (2) a wide band analog tape machine capable of high density numerical recording and reading on magnetic tape; (3) large equipment which permit (a) the direct recording on magnetic tape in numerical form, and in sequence, a group of signals of more than 80 dB dynamic range and 40 kHz total band width; and (b) the transfer in real time in the laboratory of all this information into computer storage for analysis; and (4) an editing device for numerically handling operations focusing on the identification and marking on magnetic tape portions to be analyzed and qualitative evaluations of phenomena being studied; and automatically handling operations for identifying the starting and stopping of a given analysis at precise instants. Devices in operation include a numerical energy meter which performs simple operations which must be repeatedly done, thus saving time and retards overloading the computer. S.C.W.

N68-33654 Rochester Univ., N. Y.
A THEORETICAL STUDY OF GUIDED SUBMILLIMETER THROUGH OPTICAL WAVES IN INHOMOGENEOUS MEDIA
Clark Nelson Kurtz (Ph.D. Thesis) 1967 178 p
Available from Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-13631

This work is a theoretical study of waves in a circular cylindrical, radially inhomogeneous guiding medium. The problem is formulated and analyzed from two points of view, first a scalar theory based upon the scalar wave equation of physical optics, and second a vector waveguide theory based on Maxwell's equations. In both cases the related equation method of Langer is used to obtain uniform asymptotic solutions for large values of a parameter valid over the complete range of the independent variable. In the scalar theory, a radially unbounded domain is considered, and the propagation constant is shown to depend upon a simple definite integral of the refractive index function, which is evaluated for some particular inhomogeneities. Dissert. Abstr.

N68-33681 Pennsylvania Univ., Philadelphia.
SCATTERING OF A BEAM WITH FINITE BEAMWIDTH FROM AN IMPEDANCE SURFACE
Wolfgang-Martin Boerner (Ph.D. Thesis) 1967 205 p
Available from Univ. Microfilms: HC $9.25/Microfilm $3.00 Order No. 67-12728

After a thorough literature survey on the subject of scattering from rough surfaces for large radii of curveture and small height variations, it was found that the existing theory was largely based on the plane wave solution and that little work was done on line source or dipole excitation above such rough impedance surfaces. Hitherto many scatter phenomena remained unsolved, and it was evident that further extension of the existing theory is necessary, particularly to true beam incidence on rough impedance surfaces. The exact formulation of the problem of beam scattering necessitates a three step analysis: the definition of entire beam pattern functions, the formulation of a more general scatter integral, and the derivation of the most suitable coordinate system. The entire beam pattern consisting of the amplitude and phase pattern functions are defined, and their relationships with a general aperture source distribution is derived, and the properties of such functions are characterized. Dissert. Abstr.

N68-33759 Catholic Univ. of America, Washington, D. C.
COHERENT RADIATION FROM INTENSE ELECTRON BEAMS
Richard Thomas Close (Ph.D. Thesis) 1967 156 p
Available from Univ. Microfilms: HC $7.40/Microfilm $3.00 Order No. 67-15447

The coupling of the energy of an intense relativistic electron beam to the radiation field presents a number of difficulties if conventional methods of longitudinal modulation and/or slow-wave structures are used. A promising alternative coupling mechanism employs the transverse oscillation of the beam. A theoretical analysis of this interaction reveals that the condition for radiation in a vacuum is that the phase velocity of the traveling wave on the beam be greater than the light velocity. Also it is shown that under certain conditions, marked coherence of the radiation accompanied by strong damping of the oscillation can become dominant. This dissertation deals with the first experimental efforts to investigate this transverse fast-wave phenomenon. The experimental arrangement consisted of a long vacuum tube, through which an intense electron beam was focused. Transverse traveling waves were excited on the beam and the interaction was studied in a parallel-plate transmission line. Dissert. Abstr.

N68-33780 Polytechnic Inst. of Brooklyn, N. Y.
GUIDED ELECTROMAGNETIC WAVES IN MOVING DISPERSIVE MEDIA
Henry Berger (Ph.D. Thesis) 1967 153 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-13376

Consideration is given to a modal electromagnetic wave propagation in uniform, cross-section, perfectly conducting tubular waveguides filled with dispersive media in relative motion with respect to the waveguide walls. The treatment uses relativistic field-theoretic arguments based on Minkowski's phenomenological theory of electromagnetic fields in moving media. In addition, clarification or corrections of several standard concepts and results of relativistic electromagnetics are brought out. In order to study the influence of the dispersive character of the moving media it was necessary to investigate Doppler phenomena for various forms of media. These Doppler equations and their generalizations are used extensively in the study of time-harmonic waveguide modes for both the case where the speed of the medium is nonrelativistic and when it is relativistic. An expanded Poynting's theorem is derived for nondispersive moving media and some of its implications are described. Dissert. Abstr.

N68-33825 Michigan State Univ., East Lansing.
MODIFICATION OF BACKSCATTERING OF A LOOP BY IMPEDANCE LOADING
Juang-Lu Lin (Ph.D. Thesis) 1967 199 p
Available from Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 67-14519

Modification of the backscattering of a loop by the impedance loading method is investigated theoretically and experimentally. Resonant phenomena of a loop when illuminated by an electromagnetic wave is studied, backscattering of a circular conducting loop is considered and the impedance loading method is applied to minimize its backscatter, and the minimization of the backscattering of a rectangular loop is investigated. In the theoretical analysis, a new method based on a differential equation for the loop current is developed for the case of a circular loop. For the case of a rectangular loop an existing method is applied with slight modification. Throughout the principle of superposition is applied to simplify the problem of an illuminated loaded loop to the combination of an illuminated solid loop and a radiating loop. The major objectives of the theoretical analysis are to determine the induced current on a loaded loop, the scattered field from a loaded loop and the optimum impedance which, when loaded on the loop, makes the backscatter of the loop vanish. Dissert. Abstr.

N68-33867 Colorado Univ., Boulder.
STUDY ON ELECTROOPTIC EFFECT AND ELECTROOPTIC MODULATION
Chia-Lun Hu (Ph.D. Thesis) 1966 118 p
Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-9988

This thesis reports the following new results in the study of electrooptic effect and electrooptic modulations: (1) It reports a systematic method of calculating any tensor–tensor coupling coefficients of any crystal. The linear electrooptic coefficients calculated by this method agree with other investigations. (2) It reports a new method of identifying the minimum representative group elements, or the "generators," of the 32 point groups. (3) It reports a complete synthesis of all possible first order modulation schemes with only the constraint that light does not split in space when it passes through the crystal. This experiment also provides a new method of obtaining amplitude or frequency modulation of the light beam as well as a new method of measurement of electrooptic coefficients of certain classes. (4) It reports a complete analysis and design of an open-ended cavity for use in microwave electrooptic modulators. Dissert. Abstr.

N68-33876 Michigan Univ., Ann Arbor.
WAVE PROPAGATION IN INHOMOGENEOUS MEDIA
Fred Zwas (Ph.D. Thesis) 1967 136 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-15730

In this dissertation a method based on orthogonal expansions as well as the invariant imbedding technique has been developed to solve a class of problems of wave propagation in media which are inhomogeneous in more than one direction. By expanding the solution to Maxwell's equations in terms of orthogonal functions, an infinite set of coupled first order linear differential equations with two point boundary conditions results. The technique of invariant imbedding is then employed to transform the linear boundary value problem into a non-linear initial value problem, which makes the solution by digital computers more tractable. Numerical results for the reflection and transmission coefficients as well as the field distribution are obtained for a slab whose index of refraction is a parabolic function in the direction of propagation and sinsoidal in the transverse direction. Dissert. Abstr.

N68-33884 Pennsylvania Univ., Philadelphia.
FOCAL REGION FIELDS OF A SPHERICAL REFLECTOR
Geoffrey Hyde 1967 132 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-12759

This is an investigation of the focal region fields of a spherical reflector. The geometric optics of a spherical reflector are reviewed. The classical aberrations are discussed briefly. The two caustics of the spherical reflector, the axial caustic and the caustic surface, are examined. The other major geometric optics features of the spherical reflector (the circle of least confusion, the marginal focus and the paraxial focus), are located. Finally, the formulae for path-length to a point in the focal region are reviewed. The polarization properties of the spherical reflector are then examined, using the current distribution method. Then, for an ī-polarized uniform plane wave incident on the reflector, the equation for effective current on the surface of the reflector is derived. Using this current, one is able to formulate an integral representation of the electric field at a field point in the focal region. Dissert. Abstr.

N68-33886 Missouri Univ., Columbia.
X-RAY DETERMINATION OF PARTICLE SIZE DISTRIBUTIONS
Orville Lee Brill (Ph.D. Thesis) 1967 178 p
Available from Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-13843

A study has been made of a method for determining the distribution of particle diameters in a dilute, polydisperse suspension of spherical particles with uniform electron density. Earlier studies had shown that the method, which involves an integral transform of quantities which are obtained from small-angle X-ray scattering data, was valid from a mathematical point of view and also appeared to be a promising technique for determining the distribution of particle diameters in a range from 60 to 200 A. The present work was directed toward extending the theory and to further tests of the reliability and the practicality of the method. Relationships were developed which allow one in principle to determine the value of the distribution function and its derivative for particles of zero diameter. The addition of these expressions to the theory provided alternative methods for determining more accurately the values of certain parameters which describe the behavior of the scattered intensity in the asymptotic region at angles outside the range of observation. Dissert. Abstr.

N68-33905*# Columbia Univ., New York. Columbia Radiation Lab.
A LARGE-AREA MODULAR X-RAY FOCUSING SYSTEM
F. W. Kantor, R. Novick, and T. E. Wing [1967] 20 p ref
Presented at the Intern. Symp. on Modern Optics, New York, 22–24 Mar. 1967 Submitted for publication
(Grant NsG-445; Contract DA-28-043-AMC-00099(E))
(NASA-CR-83288) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Exploitation of the properties of materials to greatly simplify construction of a large area glancing reflection X-ray gathering system is presented. This is accomplished by using surfaces of gold, vacuum evaporated onto thin, annealed glass; the surface of annealed glass is intrinsically smooth. In two different designs, these coated surfaces are arrayed as parallel plate modules and nested cones, respectively. There are no critical tolerances in arraying the surfaces. Simple tests on working prototypes have shown that a modular gathering system subtending $> 1\ m^2$ input area can easily be built, with $f \approx 5$ and efficiency $\approx 50\%$ for 10-Å X-rays. This will greatly simplify spectral and polarization measurements on all the known astronomical X-ray sources and much more sensitive sky surveys, and will facilitate μ-mesic atom studies by permitting large solid angles to be subtended by small detectors located in a low-background region away from the target. Author

N68-33985 Rice Univ., Houston, Tex.
WAVEFORM ANALYSIS USING DIGITAL TECHNIQUE
Eliezer Gottlieb (Ph.D. Thesis) 1967 84 p
Available from Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-13075

Two methods useful for the digital analysis of the spectrum of a sampled waveform are discussed. One evaluates the squared magnitude of the Fourier transform of the signal directly. For the squared magnitude of the Fourier transform of the signal, which is known as the energy density spectrum, this magnitude is evaluated using a recursive process to filter the signal by a set of discrete filters and then to measure the steady state output after the signal terminates. To determine the complex transform of the signal directly, an efficient digital method is discussed to simultaneously integrate functions of the form f(x) sin (ωx) and f(x) cos (ωx) where f(x) is slowly varying with respect to sin (ωx). The technique is based on replacing f(x) by a Taylor series expansion about the center of each cycle of the sinusoid, then integrating each term of the expansion over every full cycle, and finally summing the partial results. Dissert. Abstr.

N68-34020# Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Engineering Physics Lab.
DISTRIBUTIONS OF RELAXATION TIMES AND THEIR ARGAND DIAGRAMS
A. van Roggen [1968] 24 p refs

A comparison is made between several distribution functions of dielectric relaxation times, their corresponding frequency-dependent permittivities, and the resulting Argand diagrams. For each family of distributions, the shape of the Argand diagram changes only slowly with the parameters in the distribution. In most cases, rigorous procedures are necessary before a distribution function can be uniquely determined from experimental data. Author

N68-34040 IIT Research Inst., Chicago, Ill.
THE ELECTROGEOMETRY OF SHIELDING AGAINST LIGHTNING
Gordon Wallace Brown (Ph.D. Thesis) 1967 178 p
Available from Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-12570

The electric and geometric concepts necessary in the analysis of shielding against lightning are developed, with emphasis on their use in determining the performance of overhead transmission lines. The electrogeometry of practical transmission lines is studied, including the effects of ground angle, conductor sag, and terrain. Results of shielding failure calculations are presented in a form applicable to most real transmission lines. Also indicated are conditions necessary for perfect shielding. Comparisons with data on existing lines are made, which show excellent agreement with theory. A computer program suitable for determining the shielding performance of individual transmission lines is provided. Applications of the theory to other types of lightning protection, such as backflash and area protection, are indicated, with illustrative examples. Dissert. Abstr.

N68-34135# Tubingen Univ. (West Germany). Astronomical Inst.
IMAGE FORMATION WITH FRESNEL ZONE PLATES IN THE VISIBLE AND SOFT X-RAY REGION [ABBILDUNG MIT FRESNELSCHEN ZONENPLATTEN IM GEBIET SICHTBAREN LICHTS UND WEICHER ROENTGEN-STRAHLUNG]
H. J. Einighammer Apr. 1968 97 p refs In GERMAN; ENGLISH summary Sponsored by Bundes min. für Wiss. Forschung
(BMWF-FBW-68-27) CFSTI: HC $3.00/MF $0.65

The focussing properties of Fresnel-zone plates are investigated in the visible range. The effect of the zero order of diffraction, which is particularly disturbing when extended objects are imaged, can be eliminated subsequently by means of a pinhole camera image of the same object. For chromatic aberration an approximate formula is given and experimentally verified. The Fresnel transformation according to Mertz and Young is suitable for imaging point objects with X-rays. The angular resolution is derived and verified and the influence of the surface density of objects on the intensity repro duction is investigated. By comparison with a pinhole camera of equal resolution the optical speed of the process is yielded. Test objects are imaged in the soft X-ray region (λ = 8.3Å and 44.8Å) with micro zone plates. These are superior e.g. to optimum pinholes concerning speed and resolution. Author (ESRO)

N68-34149 Newark Coll. of Engineering, N. J.
EFFECTS OF PARTIAL COHERENCE ON HOLOGRAPHY
Michael Jay Lurie (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-14248

The theory of two-beam holography is generalized to include quasi-monochromatic radiation of any degree of spatial coherence. It is shown that a clear, undistorted reconstruction can be obtained provided the reference beam is highly coherent. The effect of the partial coherence of the illumination is only to make the reconstructed image darker. Holograms made using either a plane or a spherical reference beam are discussed in detail. A technique is developed for measuring the magnitude of the degree of coherence of the radiation at every point on the object surface, with respect to the reference beam, by measuring the irradiance at the real image reconstruction of the object. As an example, the coherence of radiation reaching a plane object from a small, circular, spatially incoherent source is measured. Motion of the object during the hologram exposure is shown to affect a quantity analogous to coherence. Dissert. Abstr.

N68-34168# Centre National de la Recherche Scientifique, Marseilles (France). Laboratoire d'Astronomie Spatiale.
STRASBOURG SUMMER SCHOOL, 3–7 JULY 1967 [COURS D'ETE STRASBOURG, 3–7 JUILLET 1967]
1967 40 p refs In FRENCH Conf. held at Strasbourg, 3–7 Jul. 1967 Sponsored by CNES
CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. PULSE COUNTING MEASUREMENTS OF THE RESPONSE OF A PHOTOMULTIPLIER E. Rodier, A. Roussin, and G. Gonczi 14 p refs (See N68-34169 21-09)

2. ANALYSIS OF MULTIDIMENSIONAL INFORMATION ON ASTRONOMICAL PHOTOGRAPHS J. M. Deharveng 25 p refs (See N68-34170 21-14)

N68-34185*# Techtran Corp., Glen Burnie, Md.
CONCERNING A CLASS SOLUTION OF THE DIRAC EQUATION [UBER EINE KLASSE VON IOSUNGEN DER DIRACSHEN GELICHUNG]
D. M. Wolkow Washington NASA Sep. 1968 Transl. into ENGLISH from Z. Physik (Berlin), v. 94, nos. 3/4, 1935 p 250–260 (Contract NASw-1695)
(NASA-TT-F-11899) CFSTI: HC $3.00/MF $0.65 CSCL 20C

Solutions of the Dirac equation are developed for the case of a sinusoidal field and the case in which the external field consists of polarized waves travelling in a certain direction and having a countable spectrum from the standpoint of frequency and initial phases. Author

N68-34187# Kyoto Univ. (Japan). Dept. of Aeronautical Engineering.
CHARACTERISTICS OF ULTRASONIC PROPAGATION IN AIR, PART 2
Hiroshi Maeda and Yoshikuni Umeda May 1968 16 p
(CP-21, Pt. 2) CFSTI: HC $3.00/MF $0.65

The characteristics of ultrasonic propagation which are particularly important for ranging in air, i.e. the variation of sound velocity due to atmospheric temperature, effects of stationary wind on the propagation of sound waves, the reflection characteristics of flat reflectors and so forth, are presented. The direction of propagation of sound waves and accordingly the propagation time in stationary wind are calculated and compared with the experimental results. Furthermore, the reflection coefficient of circular flat reflectors of various size are investigated theoretically and are compared with the experimental results, and it is found that the received acoustic pressure depends on the area of reflectors, and even if the area is finite, it is sometimes larger than the value of infinitely large reflectors. Author

N68-34217# Ghent Univ. (Belgium). Physics Inst.
ENERGY PRINCIPLE FOR GRAVITATIONAL AND MAGNETODYNAMIC STABILITY WITH APPLICATION TO FORCE-FREE FIELDS
J. G. Krüger and D. K. Callebaut (Interuniv. Inst. of Nucl. Sci., Belgium) *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 175-185 refs (See N68-34207 21-30)

An energy principle is presented (in the frame of the magnetodynamic approximation) which is the unification of the well-known energy principles for gravitational (Chandrasekhar) and magnetodynamic stability (Bernstein et al.). The stability of an infinitely long selfgravitating cylinder of constant density, with a prevalent force-free magnetic field (curl B = αB) with α constant, and surrounded by vacuum is investigated. The most general perturbation (including surface deformation) is taken into account. All force-free fields except the Lundquist field are unstable, even with a rigid wall. For the Lundquist field, the necessary and sufficient stability conditions are given. Author (ESRO)

N68-34382*# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.
CONSERVATION LAWS AND LIAPOUNOV STABILITY OF THE FREE ROTATION OF A RIGID BODY
John P. Vinti Aug. 1968 20 p refs
(Grant NGR-22-009-262)
(NASA-CR-96713; RE-48) CFSTI: HC $3.00/MF $0.65 CSCL 20

The paper derives the well known stabilities of free rotation of a rigid body about its principal axes of least and greatest moments of inertia directly from the constancy of the kinetic energy and of the square of the angular momentum. The resulting proof of Liapounov stability yields new quantitative measures of this stability. Involving only simple algebra, it depends on the fulfilling of a weak sufficient condition that insures an unchanging sign of the main component of the angular velocity ω. The quantitative results for the radii of the spheres in ω-space that occur in the Liapounov proof lead to a physical result that may be of interest. These same quantitative results for the radii of the Liapounov spheres in ω-space also lead to sufficient conditions for the rotational stability of almost spherical bodies of various shapes, prolate or oblate. They may be pertinent in designing "spheres" to be used in currently planned experiments to test general relativity by observing the rate of precession of a rotating sphere in orbit about the earth. Author

N68-34427# Army Biological Labs, Fort Detrick, Md.
THE USE OF INTERFERENCE SEPARATORY REFLECTORS IN FLUORESCENT MICROSCOPY
E. M. Brumberg and T. N. Krylova Jul. 1968 7 p refs Transl. into ENGLISH from Zh. Obshch. Biol. (Moscow), no. 14, 1953 p 461-464
(TRANS-518; AD-672109)

The brightness of the fluorescent picture observable in the microscope has a substantial importance for fluorescent microscopy. Both the ability of the eye to differentiate the form of the most minute structures of a preparation and the ability of the eye to discriminate fine color shades depend on the brightness of the image to a great degree. Considerable difficulties are commonly encountered in producing adequate brightness of picture in the fluorescent microscope. Author (TAB)

N68-34440# California Inst. of Tech., Pasadena. Antenna Lab.
A MULTIPLE SCATTERING PROBLEM
A. D. Varvatsis May 1968 147 p refs
(Grant AF-AFOSR-68-1400)
(TR-45; AFOSR-68-1086; AD-672055)

The report deals with the interaction of electromagnetic radiation with a statistical collection of nonmagnetic dielectric particles immersed in an infinite homogeneous isotropic nonmagnetic medium. The distance between any two particles is several wavelengths and the linear dimension of any particle is smaller, equal to, or greater than the wavelength. The particles are assumed to scatter line Rayleigh-Gans particles, i.e., interaction of the volume elements within a particle (self-interaction) is neglected. Multiple scattering is taken into account in the form of a series expansion of the scattered field. The terms of the series represent the multiple orders. Conditions are set up which guarantee that the multiple scattering contribution be more important than the self-interaction one. It is found that in the first order or single scattering the intensity pattern peaks in the forward direction. The multiple scattering tends to smooth out the intensity pattern. The polarization of the scattered wave is computed for the single and first order multiple scattering. If the medium is lossy the previous results do not alter, provided ((k sub ion)L) squared $<<$ 1 where k sub ion = imaginary part of the wave vector and L is the maximum linear dimension of the region occupied by the particles. In general the presence of the losses tends to reduce the forward scattering. Author (TAB)

N68-34554# Oklahoma State Univ., Stillwater. Dept. of Physics.
FIELD DEPENDENCE OF NUCLEAR SPIN RELAXATION Final Report, 25 Jun. 1964-24 Jun. 1967
V. L. Pollak 24 Jun. 1967 7 p refs
(Contract DA-31-124-ARO-D-256)
(AROD-4768-5-P; AD-672091)

A device for observing the free precession of nuclear magnetization in the earths magnetic field was constructed. The instrument was used to study spin relaxation in several liquid systems. Author (TAB)

N68-34603# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVARIANT FORMULATION OF THE THEORY OF THE GRAVITATIONAL WAVE FIELD [INVARYANTNAYA FORMULIROVKA TEORII GRAVITATSIONNOGO VOLNOVOGO POLYA]
Yu. B. Rumer 13 Sep. 1968 9 p refs Transl. into ENGLISH from Gosudarstvennyi Pedagogicheskii Inst., Novosibirsk. Uchenye Zapiski (USSR), no. 18, 1963 p 3-8
(FTD-HT-67-285; AD-672286)

The special case of gravitational radiation is singled out with the aid of the requirement that no field sources exist inside the space-time region in question. The role of field equations is played by the Bianchi identities, which assume in the weak-field approximation on a form analogous to the Maxwell equations for the electromagnetic field in vacuum. The author proposes to regard this analogy as the starting point when studying the nature of gravitational radiation. TAB

N68-34647# Los Alamos Scientific Lab., N. Mex.
POROSIMETRY DATA INTERPRETATION
J. M. Dickinson and H. D. Lewis 26 Jun. 1968 13 p refs
(Contract W-7405-eng-36)
(LA-3938) CFSTI: HC $3.00/MF $0.65

Statistical models developed for particle size analysis were used for the interpretation of porosimetry data. A brief outline of the development of the finite interval and the log normal models is given, with emphasis on assumptions and conditions required for applicability to porosimetry data. Methods of calculations based on both models are illustrated. Author (NSA)

N68-34707# Joint Inst. for Nuclear Research, Dubna (USSR).
ON THE PROBLEM OF THE INVESTIGATION OF THE FUNCTIONING STABILITY OF COMPLEX SYSTEMS
V. V. Kalashnikov 22 Mar. 1968 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 177, no. 6, 1967 p 1294–1297
(JPRS-44778)

Among the problems pertaining to a study of the common properties of the individual classes of complex systems, a significant place is occupied by the investigation of the stability of their functioning. USGRDR

N68-34726# Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.
GEOMETRIC INTERPRETATION OF PARAMETRIZED DYNAMICS
Colber G. Oliveira 1968 29 p refs *Its* Notas de Fisica, Vol. 13, No. 11
CFSTI: HC $3.00/MF $0.65

An extension for classical dynamics in general relativity is used to determine those invariant dynamical functions in the Hamiltonian representation which possess a well prescribed value when a coordinate transformation is carried out. The classical commutator algebra for those invariant dynamical functions is given and it is shown that the intrinsic value for those functions is independent of the particular coordinate condition which is used. G.G.

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N68-33651 Cornell Univ., Ithaca, N. Y.
PION PRODUCTION BY POLARIZED VIRTUAL PHOTONS
Carl William Akerlof (Ph.D. Thesis) 1967 95 p
Available from Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-16352

The reaction $e + p \rightarrow e + n + \pi^+$ was studied by detecting electrons scattered from a liquid hydrogen target in coincidence with a charged pion. The experiment was performed using the internal circulating beam of the Cornell 2.2 GeV electron synchrotron with the hydrogen target inside the synchrotron vacuum system. The scattered electrons were momentum analyzed by a single quadrupole lens and detected by a set of scintillation counters followed by a total energy lead glass shower counter. The pions were detected by a telescope of three scintillation counters. From the counting rates electroproduction cross sections were calculated. By use of the one photon exchange model the electroproduction cross sections reduced to a form equivalent to a photoproduction cross section. The azimuthal variation of these numbers was used to separate the cross section into two terms, σ_U and σ_P. The values for σ_U and σ_P were found to be in reasonable agreement with theoretical dispersion relation calculations. Dissert. Abstr.

N68-33693 Texas Univ., Austin.
OBSERVATION OF C-14 (p, α) B-11 REACTION AT BOMBARDING ENERGIES FROM 2.0 TO 3.6 MeV. TRITIUM TITANIUM TARGET DEGRADATION STUDIES
Syed Ziaur Rehman Hashmi (Ph.D. Thesis) 1967 74 p
Available from Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 67-14835

The differential cross sections for the $^{14}C(p,\alpha)^{11}B$ reaction and for the $^{14}C(p,p)^{14}C$ elastic scattering have been measured for bombarding energies $2.7 \leq E_p \leq 3.6$ MeV and at laboratory angles of 90°, 121.8°, 138.3° and 163.8°. The reaction has not been hitherto observed, and the $^{14}C(p,p)^{14}C$ scattering data represent an extension into the region $E_p > 2.8$ MeV. A study of the mechanism of deterioration of T/Ti targets under bombardment by 150 keV deuterons yielded the following results: (1) Surfaces throughout the accelerator showed characteristic Ti K X-ray activity. This is taken as evidence for "hydride" formation. (2) Target deterioration is accompanied by actual loss of tritium from the target; the building up of a carbon film, as sometimes hypothesized, is not the cause of deterioration. (3) Most of the tritium is apparently lost in gaseous form and is exhausted through the forepump. Dissert. Abstr.

N68-33697 Michigan Univ., Ann Arbor.
A MEASUREMENT OF THE FINE AND HYPERFINE STRUCTURES OF THE 2^2P STATES OF Li^7
Philip Di Lavore, III (Ph.D. Thesis) 1967 98 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-15614

This study reports an experimental determination of the fine and hyperfine structures of the 2^2P term of Li^7. The technique used for the measurements was that of level-crossing spectroscopy, wherein one takes advantage of the change of the angular distribution of the resonance fluorescence of atoms in a magnetic field which occurs when that field is such that two excited state Zeeman sublevels cross. The crossings observed in this experiment were those between the $2^2P_{3/2}$, $m_j = -3/2$, and the $2^2P_{1/2}$, $m_j = +1/2$ states. At the relatively high magnetic field required for these crossings, $\vec{J}$ and $\vec{I}$ are decoupled, so each state is separated into four hyperfine states, owing to the nuclear spin of $I = 3/2$, and thus there are actually sixteen crossings. However, only four of these produce crossover signals because the high field selection rules preclude transistions between states of different m_I. Dissert. Abstr.

N68-33704 Princeton Univ., N. J.
SPIN EXCHANGE AND LIGHT MODULATION IN OPTICALLY PUMPED SODIUM
George Antony Ruff (Ph.D. Thesis) 1967 152 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-13507

This thesis describes optical pumping, spin exchange, and light modulation experiments in samples containing sodium and hydrogen. The necessity of D_2 filter for experiments at high buffer gas pressures is demonstrated, and the construction and operation of a Zeeman filter cell for sodium resonance radiation is described. The filter constructed yields a D_1/D_2 ratio of four, and enhances observed optical pumping signals by a factor of six at low sodium vapor pressure. Improvements in the filter are proposed. The application of this filter to the detection of spin exchange polarization of hydrogen is discussed. Classical and quantum theories of the spin exchange transfer of off-diagonal information, or coherence,

are given. Experiments to detect the transfer of coherence from hydrogen to sodium are described. Sodium light beat signals at the position of hydrogen resonance appear, but only when the sodium is itself partially resonant. Dissert. Abstr.

N68-33744 Brandeis Univ., Waltham, Mass.
ANALYTICITY AND UNITARITY IN A MODEL S-MATRIX THEORY
Fong-ching Chen (Ph.D. Thesis) 1967 124 p
Available from Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-16540

A model of S-matrix theory (the extended one-pion exchange or EOPE model) is studied in the N/D formulation, with particular emphasis on the origin and effects of a certain non-unitary right-hand cut (Ω) in the partial energy variables of the S-wave multiparticle amplitude $\pi\pi N \rightarrow \pi\pi N$. The manner in which Ω is generated through partial wave projection by a pinch of the cos θ contour is analyzed. The usual extended unitarity equations connected with the physical cut (the 2'-cut) in the total energy variable which is generated by a resonance or bound-state pole in the partial energy variable are derived without extra assumptions in a model in which the left- and right-hand cuts of the amplitudes are separable. These equations are shown to be modified by the presence of Ω in the EOPE model. Dissert. Abstr.

N68-33745 Case Inst. of Tech., Cleveland, Ohio.
THE SYSTEMATICS OF MUON CAPTURE IN A NUCLEAR SHELL MODEL
Alexander Bogan, Jr. (Ph.D. Thesis) 1967 143 p
Available from Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-16060

The implications of the universal Fermi interaction hypothesis (UFI) with bare V–A coupling and conserved vector current to the total rate for muon capture in nuclei are reviewed. The total capture rates for many nuclei are calculated in a closure approximation using a nuclear shell model. It is found that restricting the model to stable nuclei greatly reduces the scatter about a straight line on a Primakoff plot. The values predicted for the weak interaction coupling constants assuming reasonable values for the average momentum of the emitted neutrinos are about two thirds of the UFI values or, if one accepts the UFI coupling constant, the necessary neutrino momentum is found to be about 10% less than one would expect. The sources of error in this model are discussed, and it is concluded that the inability to accurately predict the total capture rate stems from the difficulty in choosing an appropriate average neutrino momentum as required by the closure approximation. Dissert. Abstr.

N68-33746 California Univ., Davis.
EXPERIMENTAL INVESTIGATION OF PARTICULAR FINAL-STATE DECAY MODES FOLLOWING PHOTO-PARTICLE REACTIONS IN O_{16}
John Thomas Caldwell (Ph.D. Thesis) 1967 127 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-14966

Two independent experiments investigating particular final-state decay modes following photo-particle reactions in O^{16} have been carried out with monoenergetic photons over the giant resonance region of 17 to 29 MeV. In the first experiment, a 4 π neutron detector-spectrometer was used to obtain information on ground and excited-state transitions in the O^{16} (γ,n) reaction. In the second, de-excitation γ-rays following $O^{16}(\gamma,n\gamma')$; $\gamma,p\gamma')$; and $\gamma,\alpha\gamma')$ reactions were detected. By combining the results of the two experiments, a total of individual decay-mode cross sections were determined, including three sets of O^{15}–N^{15} mirror-level decays and the O^{16} $(\gamma,\alpha\gamma')$ C^{12} (15.1 MeV final state) reaction. Seven of these decay modes had not been observed previously and none had been investigated with monochromatic photons. Dissert. Abstr.

N68-33747 Colorado Univ., Boulder.
SCATTERING OF HELIUM 3 FROM MEDIUM WEIGHT NUCLEI AT 37.7 AND 43.7 MEV
Edward Fergus Gibson (Ph.D. Thesis) 1968 188 p
Available from Univ. Microfilms: HC $8.60/Microfilm $3.00 Order No. 67-9982

The scattering of 37.7 and 43.7 MeV He^3 ions from medium weight nuclei was studied in order to investigate both the optical model for He^3, and He^3 as a nuclear spectroscopic tool. He^3 ions were scattered from Ca^{40}, Fe^{56}, and Ni^{58} at 37.7 MeV and from Ni^{58}, Y^{89}, and Zr^{90} at 43.7 MeV. The energy resolution ranged from 100 to 200 keV. Elastic angular distributions were obtained in the angular range from 3° to about 90° for all targets and were extended to 120° in the case of Zr^{90}. Inelastic distributions for the more strongly excited states were obtained in the angular range from 15° to about 90°. The (He^3, α) reaction was also observed for the target nuclei Ni^{58}, Y^{89}, and Zr^{90}. The (He^3, α) reaction is shown to be vary useful in studying states of nuclei obtained by neutron pickup, and several new states in Y^{88} and Zr^{89} are found. Dissert. Abstr.

N68-33749 Rensselaer Polytechnic Inst., Troy, N. Y.
THERMAL NEUTRON SPECTRA AND INTEGRAL PARAMETERS IN HETEROGENEOUS SYSTEM
Joseph James Bulmer 1967 201 p
Available from Univ. Microfilms: HC $9.25/Microfilm $3.00 Order No. 67-12829

An integral method is developed to determine energy dependent neutron spectra and integral parameters such as the thermal utilization factor, f and the thermal reproduction factor, η, in heterogeneous systems. The method utilizes the collision probability approach to provide a coupled set of equations more transparent physically than the straightforward but unwieldy techniques used in solving the thermal space-energy problem. The first portion of the work makes use of full scattering matrix representations of the scattering law to provide estimates of the errors in both the spectra and integral parameters due only to the spatial approximations in the collision probability approach. The flat flux approximation employed in the collision probability method was investigated to determine the extent of the errors in the collision probability due to the use of this approximation. An approximation in the integral equation – collision probability approach is made which involves the use of an extremely simple expression for the scattering law. Dissert. Abstr.

N68-33757 Colorado Univ., Boulder.
MEASUREMENT OF THE CROSS SECTION FOR DETACHMENT OF ELECTRONS FROM THE NEGATIVE HYDROGEN ION BY ELECTRON IMPACT
Gary Carman Tisone (Ph.D. Thesis) 1966 105 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-10016

The cross section for the detachment of an electron from H^- by electron impact has been measured for electrons with energies of 30 eV to 500 eV. This cross section was measured using crossed-beam and AC modulation techniques. The theory of these experimental techniques is developed and the apparatus used in this measurement is described. The limitations of the experimental technique due to noise and spurious effects are discussed. Possible sources of limiting noise and their relative importance to this crossed-beam experiment are discussed. The theory of the double-modulation technique that was used in this measurement is also presented. The description of the crossed-beam apparatus includes a description of a neutral particle detector that was designed to satisfy the requirements of the experiment. The results of this measurement are compared with the theoretical calculations that have been done on the negative ion detachment process. These calculations differ by two orders of magnitude. Dissert. Abstr.

N68-33758 Colorado Univ., Boulder.
INVESTIGATION OF THE ROLE OF PHOTONS IN THE NON-RELATIVISTIC MANY-BODY PROBLEM
Charles Ray Smith (Ph.D. Thesis) 1967 154 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-15053

On the basis of the formulation of quantum statistics of Mohling, the role of photons in a multicomponent system of charged particles in thermal equilibrium is investigated in the non-relativistic region. The momentum distribution for photons is calculated to second order in the fine-structure constant. In the course of the investigation divergences are encountered, and this divergence problem is formulated quite generally as a set of integral equations so that peratization can be applied; due to mathematical complexities no useful solution is obtained, although insight is gained by the physically intuitive formulation of the problem. The divergences are then removed through a mass-renormalization program, formulated to second order in the free-structure constant. The entire investigation is generally valid for absolute temperature $T \leq 10^6$ °K and for all particle densities $\rho << 10^{24}$ particles/cm^3. Dissert. Abstr.

N68-33763*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MEASUREMENT OF THE B 10 (n, α) Li 7, Li 7* RELATIVE CROSS SECTIONS IN THE keV REGION
Donald Bogart and Lowell L. Nichols (Battelle-Northwest) Washington Sep. 1968 25 p refs
(NASA-TN-D-4783) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Relative cross sections for $^{10}B(n,\alpha)^7Li$, $^7Li^*$ were obtained from measurements of the counting ratios of a $^{10}BF_3$ proportional counter and a precision long counter used to monitor relative neutron fluxes. Monoenergetic neutrons were produced by a Van de Graaff accelerator in the energy region from 30 to 800 keV. When the relative cross sections are normalized to a $1/v$ variation below 80 keV, the data lie above a $1/v$ line from 80 to 550 keV indicating departures of 15 percent at 140 keV and 20 percent at 220 keV. Recommended cross sections for $^{10}B(n,\alpha)^7Li$, $^7Li^*$ up to 1 MeV are obtained from recently available measurements and the known levels in ^{11}B. Author

N68-33777 West Virginia Univ., Morgantown.
PROTONS FROM 14.3 AND 16.6 MeV NEUTRON INDUCED REACTIONS IN Cu 63
Jerry Kenneth Eddy (Ph.D. Thesis) 1967 133 p
Available from Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-11782

The energy spectra and angular distributions of protons produced from bombarding $_{29}Cu^{63}$ with 14.3 MeV and 16.6 MeV neutrons were studied. These studies were made with a proton telescope using two CsI(Tl) transmission counters and a CsI(Tl) total absorption crystal. Proton energy spectra were taken at 0, 20, 45, 70, 95 and 120 degrees with the neutron beam for both neutron energies. The energy spectra were compared with the theoretical cross-sections calculated from the statistical model of the nucleus and the volume direct interaction theory of nuclear reactions. For the 14.3 MeV incident neutrons, the proton spectra showed peaks at 9 MeV, 10 MeV and 13.5 MeV. Nuclear temperatures were determined at each angular position giving 1.2 MeV at 0°, 1.63 MeV at 20°, 1.63 MeV at 45°, 1.53 MeV at 70, 1.63 MeV at 95°, and 1.63 MeV at 120°. The average nuclear temperature is 1.54 MeV. From the angular distributions, the percentage of direct interactions present above 5 MeV protons was estimated to be 25%. Dissert. Abstr.

N68-33813# Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.
FIELD THEORY OF ELEMENTARY DOMAINS AND PARTICLES. PART I
Yasuhisa Katayama and Hideki Yukawa Jul. 1968 44 p refs
(RIFP-76) CFSTI: HC $3.00/MF $0.65

A brief historical account is given on the developments in the efforts to construct a unified theory of elementary particles based on the assumption that each particle is a quantum mechanical object extended in space and time. As the most simple model, essential features of bilocal field theory are discussed first. Generalization to multilocal field and the derivation of various quantum numbers, which are ascribed to hadrons, from the quantization of internal motion are discribed. Author

N68-33818 Texas A&M Univ., College Station.
DETERMINATION OF THE PROPERTIES OF NUCLEAR ENERGY LEVELS BY THE RESONANCE FLUORESCENCE OF NEUTRON CAPTURE GAMMA RAYS
Shankarnarayan Ramchandran (Ph.D. Thesis) 1967 139 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-16471

Several cases of nuclear resonance scattering below the neutron emission threshold energy region have been observed using discrete gamma rays produced by the radiative capture of neutrons in elements. Eight such cases were studied (8.496 MeV in Zr; 7.64 MeV in ^{203}Tl; 7.416 MeV in ^{209}Bi; 7.277 MeV in ^{208}Pb; 7.149 MeV in ^{209}Bi; 7.01 MeV in Sn; 6.474 MeV in Cd; 4.903 MeV in Hg) and the angular momentum of the excited states were determined by measuring the angular distribution of resonantly scattered gamma rays. In all these cases the observed transition was a dipole type. In the first five of the above cases, where the resonance scattering competes favorably with non-resonance scattering, a resonance self-absorption and a scattering experiment were performed to obtain information on the level widths. The observed range of ground state transition widths varies from a few tenths of an eV to a few eV. From a comparison of the values of radiative transition widths of the virtual states obtained from neutron resonances, the measured values of the level widths for the γ-ray transitions below the neutron emission threshold reported in this investigation are larger by approximately a factor of 10 in most of the cases. Dissert. Abstr.

N68-33824 Indiana Univ., Bloomington.
PRODUCTION OF CASCADE AND TWO-HYPERON FINAL STATES IN NEGATIVE KAON DEUTERON INTERACTIONS AT 2.24 BEV/C
John Paul Chandler (Ph.D. Thesis) 1967 68 p
Available from Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 67-15073

This thesis concerns the analysis of cascade, lambda-lambda, and sigma-lambda final states in a K⁻-d bubble chamber experiment performed at the Brookhaven Alternating Gradient Synchrotron. The partial cross-sections for the various final states are tabulated and compared with previous results, either directly, or indirectly, assuming conservation of isotopic spin. The cross-section for Ξ^-K^0 seems anomalously small (≤ 14 μ b). The cascade final states cannot be reached via the exchange of a single known meson. For most of these states the angular distribution of the cascade in the barycentric system is peaked in the forward direction, indicating the possible operation of a baryon exchange mechanism. Probable cascade-pion resonances are observed near 1530 MeV and 1700 MeV in the $\Xi_\pi KN$ final states. No evidence for any two-baryon resonances has been found. Dissert. Abstr.

N68-33860# Cekmece Nuclear Research Center, Istanbul, (Turkey).
PARAMETERS FOR THE FIRST AND SECOND NEUTRON RESONANCES IN SM 149
O. R. Akyuz, C. Cansoy, F. Domanic, and Y. Orgenvren Jun. 1968 15 p refs
(CNAEM-52) CFSTI: HC $3.00/MF $0.65

The total neutron cross section of natural samarium was measured in the energy range from 0.06 to 1 eV with a crystal spectrometer using the Be(10T1) and Be(1231) crystal planes as monochromators. In this region two resonances due to ^{149}Sm

are present. After correction for second order contamination caused by the monochromator, Doppler corrections have been applied to both resonances. Corrections for spectrometer resolution were needed only for the second resonance. Both resonances were fitted separately to the Breit-Wigner single-level formula by the method of least squares. The analysis gives the parameters of the resonances as follows: $E_0 = 0.0973 \pm 0.0012$ eV, $\sigma_0 = 18348 \pm 376$ b, $\Gamma = 0.0635 \pm 0.0013$ eV, $\Gamma_n = (0.0773 \pm 0.0025) \times 10^{-3}$ eV for the first and $E_0 = 0.872 \pm 0.012$ eV $\sigma_0 = 2948 \pm 68$ b, $\Gamma = 0.0635 \pm 0.0015$ eV, $\Gamma_n = (0.1114 \pm 0.0041) \times 10^{-3}$ eV for the second. The statistical weight factor g is taken to be 9/16 for both levels. Author

N68-33866*# Pittsburgh Univ., Pa.
CONTRIBUTIONS TO THE EIGHTH INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES
E. Gerjuoy [1967] 33 p refs Meeting held in Vienna, 27 Aug.–2 Sep. 1967 Submitted for publication
(Grant NGR-39-011-035; Contract DA-31-124-ARO-D-440)
(NASA-CR-89216) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The contribution consists of a brief summary of the principal presentations at the Fifth International Conference on the Physics of Electronic and Atomic Collisions, held at Leningrad, July, 1967. This summary is followed by a survey of papers on electron-atom collision theory presented at that conference. The survey traces recent developments and progress in electron-atom collision theory, including collisions between electrons and atomic ions, neutral molecules, or molecular ions. Problems are discussed concerning the calculation of close-coupling, collision cross sections, molecular wave functions, scattering cross sections, positron scattering, resonances, dielectric recombination, angular distribution measurements, and various types of nuclear reactions. K.W.

N68-33877 Case Inst. of Tech., Cleveland, Ohio.
THE NUCLEAR G-FACTORS OF THE 2 + ROTATIONAL STATES IN NEODYMIUM 150, DYSPROSIUM 162 AND 164, AND ERBIUM 166, 168, AND 170
James Daniel Kurfess (Ph.D. Thesis) 1967 147 p
Available from Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 67-16084

The nuclear g-factors and mean lives of the 2+ rotational states of Nd^{150}, Dy^{162}, Dy^{164}, Er^{166}, Er^{168}, and Er^{170} have been measured by the pulsed beam technique. The time differential precession of the angular distribution of the de-excitation gamma radiation was measured following coulomb excitation by a pulsed proton beam. Metallic neodymium targets and dysprosium-copper and erbium-copper liquid eutectic targets were used at about 900°C. Paramagnetic correction factors for free tripositive ions were used in the g-factor calculations. Strong perturbations causing an exponential attenuation of the anisotropy of the angular distribution were observed in the liquid targets. These perturbations are interpreted to be magnetic in character, and the exponential decay constants, λ_2, are calculated. Dissert. Abstr.

N68-33887 Catholic Univ. of America, Washington, D. C.
APPLICATION OF THE PARTICLE-HOLE MODEL TO ELECTROEXCITATION AND MUON CAPTURE IN LIGHT NUCLEI
Lemmuel Le Roy Hill, Jr. (Ph.D. Thesis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-15452

In this study results are obtained for each of the five, light, magic number, nuclei ^{12}C, ^{16}O, ^{28}Si, ^{32}S, and ^{40}Ca. In the framework of the one particle one hole model with a Serber residual interaction the negative parity J = 0, 1 and 2, T = 1 eigenstates are calculated. These results are then used to determine the E1 and M2 squared reduced matrix elements for inelastic electron scattering for values of momentum transfer from 0 to 300 MeV/c. The nucleon decay widths of the 1^- and 2^- states are calculated from R-matrix theory and used in conjunction with the E1 and M2 matrix elements and the Breit–Wigner formula to determine the excitation spectra for photo-nuclear and 180° inelastic electron scattering reactions. In addition the matrix elements for muon capture are calculated for all three couplings and the total muon capture rate is determined. Dissert. Abstr.

N68-33888*# Pittsburgh Univ., Pa.
THEORETICAL ASPECTS OF ATOMIC COLLISIONS, 2
E. Gerjuoy [1967] 15 p refs Presented at the 5th Intern.Conf. on Electron. and Atomic Collisions, Leningrad, Jul. 1967 Submitted for publication *Its* Space Res. Coord. Center Rept.-58
(Grant NGR-39-011-035; Contract DA-31-124-ARO-D-440)
(NASA-CR-89217) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A series of three invited talks by different speakers summarizing the theoretical contributions to the Leningrad conference were delivered at this plenary session. The talk in this report, the second of the aforementioned series, concentrates on the relatively unconventional theoretical papers heard at Leningrad, specifically on the developments falling under the three headings: (1) classical methods; (2) variational methods and bounds; and (3) Faddeev equations. In general, topics falling under these headings lie somewhat further from the present mainstream of atomic collision theory than do most topics in the theory of atomic collisions. Author

N68-33892 Rutgers Univ., New Brunswick, N. J.
K+ THREE BODY LEPTONIC DECAY MODES
Samuel Leslie Marateck (Ph.D. Thesis) 1967 61 p
Available from Univ. Microfilms: HC $3.60/Microfilm $3.00 Order No. 67-14739

From an exposure of K+ stoppings in the Brookhaven 30 in. propane chamber, the K_{e3} and $K_{\mu 3}$ Dalitz plots for lepton momenta below 120 Mev/c have been studied. $K_{\mu 3}$ decays were separated from K_{e3} decays by physicists examining the lepton's ionization, radiation loss and range. The lepton momentum is measured directly and the π^0 momentum is obtained by measuring its decay gamma ray directions and the conversion electron-positron pair momenta. The π^0 momentum error is typically 5%. Because of this resolution, the $K_{\mu 3}$ and π' modes can be separated and thus the $K_{\mu 3}$ Dalitz plot below 120 Mev/c is free of π' background. Dissert. Abstr.

N68-33893 Cornell Univ., Ithaca, N. Y.
PION PRODUCTION AND PION NUCLEON SCATTERING
Nitya Ranjan Nath (Ph.D. Thesis) 1967 233 p ref
Available from Univ. Microfilms: HC $10.60/Microfilm $3.05 Order No. 67-13922

Attempts to make a systematic study of the effect of production reactions ($\pi N \rightarrow \rho N$, and $\pi N \rightarrow \pi N^*$) on elastic pion-nucleon scattering were made. This work is concerned with the unitarization of long-range, inelastic Born graphs, and is essentially a generalization and, in some sense, a simplification. We have included both one-pion-exchange in the reaction $\pi N \rightarrow \rho N$ and nucleon-exchange in the reaction $\pi N \rightarrow \pi N^*$ as "inputs," and have treated the instability of ρ and N^* more seriously. Multi-channel unitarity (Blankenbecler's version), comprising all amplitudes which connect πN, ρN and πN^* states, has been imposed and is rigorously satisfied by the solutions. Dissert. Abstr.

N68-33894 Washington State Univ., Pullman.
THE BREAKUP OF C-12 AT 26 MeV EXCITATION
Dusan Charles Pecka (Ph.D. Thesis) 1967 63 p
Available from Univ. Microfilms: HC $3.60/Microfilm $3.00 Order No. 67-15758

Differential cross-sections for the reaction $^{10}B(d,d)^{10}B$ were measured at a laboratory angle $\theta_{LAB} = 156°$ for deuteron bombarding energies between 900–1150 keV. The peak at $E_d =$

980 keV is attributed to a state in ^{12}C corresponding to an excitation energy of 26.00 ± .01 MeV. The decay of the 26 MeV level in ^{12}C into three alpha particles was examined in a plane perpendicular to the beam direction. A study of the coincidence spectra obtained with two silicon surface-barrier detectors suggests primarily sequential breakup through the $^{8}Be(2.9)$, $^{8}Be(g.s.)$ and to a smaller extent through the $^{8}Be(11.4)$ state. Assuming that the 26 MeV level is formed by s-wave deuterons, an angular correlation analysis of the α-α cascade proceeding through the $^{8}Be(2.9)$ state was carried out. The results indicate that 2^+ and 4^+ are possible spin and parity assignments for the ^{12}C state, whereas the 3^+ assignment does not appear to be consistent with the observed correlation. Dissert. Abstr.

N68-33930# Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.

SUPERCONVERGENCE RELATIONS IN Π-A_1 SCATTERING

P. P. Srivastava and C. P. Korthals Altes (Amsterdam Univ.) 1968 8 p *Its* Notas de Fisica Vol. 13, No. 12 Submitted for publication

CFSTI: $3.00

Strong interaction superconvergent sum rules are discussed for the axial vector meson A_1 and π scattering in the forward case (t = 0). The π-A_1 scattering amplitude is written in terms of four invariant amplitudes, which lead to three superconvergent dispersion relations for $t \approx 0$. Coupling constant sum rules obtained by saturating these relations with a number of s-channel resonances are derived, and it is found that one of the higher known resonances must be included to obtain nonvanishing values for the couplings. Even then a solution consistent with the decay widths of the particles in not possible, and it is concluded that presently known resonances cannot saturate these sum rules. Author

N68-33941 California Inst. of Tech., Pasadena.

NEUTRAL PION PHOTOPRODUCTION FROM THE DEUTERON AT FORWARD ANGLES IN THE ENERGY RANGE FROM 900 MeV TO 1400 MeV

Carl Rudolph Clinesmith (Ph.D. Thesis) 1967 118 p

Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-14345

The cross section for the reaction $\gamma + d \rightarrow \pi^0 + p + n$ was measured. The π^0 was detected by measuring its decay gamma rays with two lead glass, total absorption Cherenkov counters. The results are three angular distributions at k = 911, 1180, and 1390 MeV, at forward angles from 3 degrees to 90 degrees. The deuteron/proton ratio differs significantly from 2.0, but final state effects from the use of a deuteron target make impossible quantitative conclusions about the neutron cross section. Dissert. Abstr.

N68-33958# Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.

FIELD THEORY OF ELEMENTARY DOMAINS AND PARTICLES, PART 2

Ysuhisa Katayama, Isao Umemura, and Hideki Yukawa Jul. 1968 60 p refs Submitted for publication

(RIFP-77) CFSTI: HC $3.00/MF $0.65

The field is defined on the closed domain in the space–time world and is described by fourteen variables, i.e. by the coordinates of the center, invariant deformable lengths and generalized four-dimensional Euler angles. The combination of six Euler angles and two invariant lengths gives a complex four-component spinor operator by which the eigenstates of internal spin are determined. The fundamental field equation is introduced based on a simple geometric consideration of periodicity among the elementary domains and analyzed on a line similar to the infinite component theory. Also the second quantization is discussed mainly in connection with the finite difference character of the field equation and the simultaneous preparation of the four-dimensional elementary domains in the four-dimensional manifold is assured from the commutability of the fields of domains separated by a finite distance in space-like and time-like directions. Author

N68-33969 Tennessee Univ., Knoxville.

SPECTROSCOPIC STUDY OF THE PROTON GROUND STATE CONFIGURATIONS IN THE ZIRCONIUM ISOTOPES

Barry Mason Preedom (Ph.D. Thesis) 1967 110 p

Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-15785

An investigation of the proton ground state configurations in the even zirconium isotopes was undertaken using the (d, ^{3}He) reaction. The effect of adding pairs of $2d_{5/2}$ neutrons on the $(2p_{1/2})^2 + (1g_{9/2})^2$ proton admixture known to exist in ^{90}Zr was studied as an indication of the relative strengths of the p–d and g–d proton-neutron interactions. Enriched targets of the zirconium isotopes (A = 90, 92, 94, 96) were bombarded using a 34.4-MeV deuteron beam from the Oak Ridge Isochronous Cyclotron. A ΔE–E Si surface barrier detector telescope was used to obtain ^{3}He angular distributions leading to states of less than 3.0-MeV excitation in the yttrium isotopes (A = 89, 91, 93, 95). The experimental angular distributions were compared with distorted wave calculations using a local zero-range approximation and a finite-range approximation which included non-locality in the distorted waves. Optical parameters used in the calculations were obtained from 34.4-MeV deuteron elastic scattering from the zirconium isotopes and from 24.7-, 30.7-, and 41-MeV ^{3}He elastic scattering from ^{89}Y. Dissert. Abstr.

N68-34006# Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.

ISOTROPY IN π–μ DECAYS

E. Frota-Pessoa 1967 19 p refs *Its* Notas de Fisica, Vol. 13, No. 7

CFSTI: HC $3.00/MF $0.65

An extensive analysis is made of all results on the angular distribution of π–μ decays in the nuclear emulsion stack used by Hulubei et al. Contrary to their previous analyses, which favoured anisotropy for this distribution, it is shown that no strong indication of anisotropy subsists which is free from serious suspicion of residual uncorrected bias. The safe part of the scanning of that stack is in good agreement with isotropy. Author

N68-34014# Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.

FIVE DIMENSIONAL FIELD THEORY

Colber G. Oliveira 1967 24 p refs *Its* Notas de Fisica, Vol. 13, No. 9

CFSTI: HC $3.00/MF $0.65

A unitary field theory is constructed in a Riemannian space R_5 which has cylindrical symmetry with respect to a unit vector field. The field is described by fifteen potentials $\gamma_{\mu\nu}$ which satisfy in absence of external sources the five dimensional Einstein's equations $G_{\mu\nu} = 0$. It is shown that a four dimensional analysis of this theory includes three types of force fields, the electromagnetic field, the gravitational field as described by general relativity and a relativistic scalar field. Author

N68-34015# Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.

ON A PARITY VIOLATING NUCLEON–NUCLEON POTENTIAL

R. Lacaze 1967 28 p refs Submitted for publication *Its* Notas de Fisica, Vol. 13, No. 8

CFSTI: HC $3.00/MF $0.65

A static parity violating nucleon–nucleon potential due to the two pion exchange is constructed, assuming the current–current and CVC hypotheses for weak interactions. Rescattering terms as well as the $\pi\pi$ P-wave in the strong π–N vertex are taken into account. Our results differ from those obtained in a perturbation calculation for the strong interaction; namely, the range of our potentials is longer and this might modify Partovi's results for the asymmetry coefficients in photodisintegration of the deuteron. Author

N68-34019# Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.
KAON YIELDS KAON RESONANCE PION AND KAON RESONANCE YIELDS KAON PIONS
Prem P. Srivastava 1968 12 p refs /ts Notas de Fisica, Vol. 13, No. 10
CFSTI: HC $3.00/MF $0.65

Strong decays $K_A \rightarrow K^*\pi$ and $K^* \rightarrow K\pi$ are studied using current algebra, partial conservation of axial current, dispersion relations and Weinberg sum rules. The pions are treated as "soft" in the sense $k^2 \rightarrow 0$ instead of $k \rightarrow 0$. Author

N68-34031 Cincinnati Univ., Ohio.
HYDROGEN BONDS AND OTHER ION-MOLECULE INTERACTIONS
Rose Mary Deiters (Ph.D. Thesis) 1967 164 p
Available from Univ. Microfilms: HC $7.60/Microfilm $3.00 Order No. 67-15957

In this research, the enthalpy of formation of ion-molecule species was measured in gas-solid systems and the results interpreted in the light of several current theories of ion solution. In order to circumvent the problems associated with solution studies of ion-solvent interactions, the systems studied here were limited to those which result in compound formation between gaseous solvent molecules and ionic solids. The solids consisted of the ion of interest and a large inert co-ion. Using standard vacuum line techniques, the enthalpy of formation of an ion-molecule species was determined from the variation of the adduct decomposition pressure with temperature. The composition of the species formed was determined from a pressure-composition phase study. Dissert. Abstr.

N68-34033 Junta de Energia Nuclear, Madrid (Spain). Div. de Geologia.
RADIOACTIVE EQUILIBRIUM. 1: β γ METHOD FOR MEASUREMENT OF eRa/U. EVALUATION OF U_3O_8 CONTENT [DESEQUILIBRIO RADIACTIVO. 1: METODO β γ. DETERMINACION DE LA RAZON eRa/U. VALORACION DEL CONTENIDO EN U_3O_8]
E. Mingarro 1966 130 p refs In SPANISH; ENGLISH summary
(JEN-167-SIG/I-5) CFSTI: $3.00

The main problems concerning the radioactive nonequilibrium of minerals, and a simultaneous counting procedure for β and γ activities developed to solve those problems, are described. Author

N68-34103*# Stanford Research Inst., Menlo Park, Calif.
RECENT PROGRESS IN ATOM–ATOM COLLISION THEORY
Felix T. Smith [1967] 23 p refs Presented at the 6th Intern. Conf. on Phenomena in Ionized Gases, Vienna, 27 Aug.–2 Sep. 1967 Submitted for publication
(Contract NASr-49(07))
(NASA-CR-89190) CSCL 20H

The velocity criterion for inelastic scattering ($v_{el}/v_{in} \approx 1$), the Massey adiabatic parameter, and the Landau–Zener parameter are compared and the relations between them are clarified in the light of current work. Theory has been healthily affected by recent experimental developments, which show that the simplest version of Massey's criterion is of very questionable usefulness, whereas the Landau–Zener criterion is of ever-increasing importance. Interference effects are turning out to be almost universally prevalent in low energy scattering, both elastic and inelastic; interferences connected with a curve-crossing are especially prominent in recent data. Shell structure effects are being increasingly recognized, and it seems that inner shell behavior can be treated by the same methods that are valid for outer shells. Adiabatic and nonadiabatic potential curves and interaction matrix elements are very important for all these processes, and it is becoming increasingly feasible to deduce these functions from scattering data. Author

N68-34104 Brandeis Univ., Waltham, Mass.
APPLICATIONS OF THE ABSORPTIVE ONE PION EXCHANGE MODEL
Robert David Gordon (Ph.D. Thesis) 1967 110 p
Available from Univ. Microfilms: HC $5.40/Microfilm Order No. 67-16551

The one pion exchange model, corrected for absorption in the initial and final states is derived and examined for two body reactions involving the production of low and high spin particles. It has been observed that the standard formulation of the model overestimates the reaction cross section for high spin final states by a factor of approximately two. It is found that the inclusion of a non-rapidly varying form factor brings theory into agreement with experiment for a number of reactions involving high spin final states. Here the specific reaction studied is f^0 meson production by pions off nucleons. The modal is next applied to the production of the recently reported S^* meson by pions off nucleons to determine coupling constants with the subsequent attempt to set up a new multiplet. Because of the low spin of the S^* meson (S = 0) the standard formulation of the model has been used. Dissert. Abstr.

N68-34138# International Centre for Theoretical Physics, Trieste (Italy).
ON THE ZERO ENERGY BEHAVIOR OF REGGE POLES AND RESIDUES
Abdus Salam and J. Strathdee May 1968 61 p Presented at the 8th Nobel Symp. on Elementary Particle Theory, Trieste, Italy, May 1968 Submitted for publication
(IC-68/31; CONF-680519-1)

The behavior of partial wave amplitudes in the neighborhood of vanishing momentum is studied in the Born approximation. A set of phenomenological fields is introduced to assist in the construction of a kinematically correct Born term. It is found that the Born contribution to the partial wave amplitudes has a structure which, as a result of the kinematical properties of the phenomenological propagator and vertex parts, yields considerable information about the behavior of Regge poles and residues at zero energy. Regge poles arrived at in this way group themselves into Toller families whose zero energy intercepts, slopes, etc., are severely constrainted. Asymptotic formulas for forward scattering amplitudes are obtained. Author (NSA)

N68-34139# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
DO WE KNOW HOW TO DISTINGUISH BETWEEN PERIPHERAL AND CENTRAL HIGH-ENERGY MANY-BODY COLLISIONS?
Lech Michejda 1968 27 p refs
(INR-P-889/VI/PH)

The idea of peripheral or central high-energy collisions is expressed in terms of partial inelastic cross sections σ_1 corresponding to the initial particles being in the angular momentum state 1. Various attempts to determine the total angular momentum J of the many-body states and hence also of the cross sections σ_1 via the overlap function are discussed. It is shown that for the 8 GeV/c π^+p interactions neither the uncorrelated jet model nor the multi-Regge-exchange model yield the angular momenta which would satisfy the unitarity condition of the S-matrix, unless the variable phase of the wave function is introduced. From the fact that most of the anisotropy required by the high values of J expected from the data on elastic scattering is hidden in a phase dependence, and from a study of models with variable phase, it is concluded that at the moment it is not possible to solve the question of distinguishing between peripheral and central collisions. Author (NSA)

N68-34145# Institutt for Atomenergi, Kjeller (Norway).
FLIPPER-CHOPPER FOR POLARIZED SLOW NEUTRONS
A. Virjo and O. Steinsvoll Feb. 1968 76 p refs
(KR-125)

By suitably varying the parameters of a neutron spin resonance flipper ordinarily used in diffractometers for polarized slow neutrons, it is possible to pulse the flipper into or out of resonance for short periods to obtain short bursts of neutrons with reversed polarization. A device operating as above is called a flipper-chopper. The bursts can then be used in connection with the time-of-flight method to measure the scattered neutron energy for the polarization dependent part of a scattering process, that takes place after the flipper-chopper. Theory of the flipper-chopper was studied with a simplified model, where the neutron beam is assumed to be limited to the symmetry axis of the flipper coil. The flipper coil geometry may be arbitrary in other respects, but the field produced by it (on the symmetry axis) must be directed along the axis. The main magnetic field has been assumed homogeneous in direction, but can be otherwise arbitrary. Three possible flipper-chopper principles are discussed, paying special attention to resolution, namely main field pulsing, r.f. current pulsing, and main field sweeping. A prototype using main field pulsing has been built and successfully tested. The results do not, however, agree quantitatively very well with theory, e.g., the smallest pulse widths achieved have been ~1.5 times greater than the theory predicts. Author (NSA)

N68-34155# European Atomic Energy Community, Geel (Belgium). European American Nuclear Data Committee.
NUCLEAR DATA RESEARCH IN THE EURATOM COMMUNITY Progress Report, 1 Jan.–31 Dec. 1967
Feb. 1968 239 p refs
(EANDC-(E)-89U)

Research activities and programs in the EURATOM community during the period Jan. 1 to Dec. 31, 1967, are summarized. Neutron cross section measurement programs comprise the bulk of the material included. NSA

N68-34175*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ADSORPTION-DESORPTION BEHAVIOR OF HOMOGENEOUS AND HETEROGENEOUS METAL SURFACES
Thaine W. Reynolds Washington Sep. 1968 46 p refs
(NASA-TN-D-4789) CFSTI: HC$3.00/MF$0.65 CSCL 20L

Energy distribution relations which describe the desorption behavior from heterogeneous surfaces are presented. A graphical method of obtaining these is described, and the results are compared with a more exact computer-determined solution. Adsorption isotherms representing equilibrium coverage for the systems H_2–W, CO–W, N_2–W, CO–Mo, and N_2–Mo are presented covering a pressure range from 10^{-12} to 1 torr, a fractional surface coverage from 0.02 to 0.98, and for the appropriate temperature range in each case. Author

N68-34212# Bulgarian Academy of Science, Sofia. Inst. of Physics.
A MULTITEMPORAL THEORY OF RELATIVITY AND ITS APPLICATIONS TO QUASARS AND TO ELEMENTARY PARTICLES
Nikola S. Kalitzin *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 81-123 refs (See N68-34207 21-30)

It has been reported that quasars present radioflux variations with periods of some months although it had been proved that they were far away objects. No explanation of this can be found in a four dimensional space. It is shown that in a multidimensional space all dimensions except the three first ones are time-like and that it must be admitted that along these dimensions there is no velocity limit. The n-dimensional pseudoeuclidian space is investigated and the corresponding equations established. It is shown that there are no other conservation laws than the law of conservation of momentum. Electrodynamic equations are computed and applied to the quasar problem. Dirac's equation is generalized in the spaces E_{3+3} and E_{3+9}. A short investigation is made of a Riemannian n-dimensional space to gain an approximate picture of the probable development of a quasar. ESRO

N68-34270# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
NUCLEAR REACTOR PHYSICS
P. J. Grant 18 Oct. 1966 22 p
CFSTI: HC$3.00/MF$0.65

Experiments carried out on energy spectrum analysis, neutron diffusion length and influence of moderator temperature are described. ESRO

N68-34275# Deutches Elektronen-Synchrotron, Hamburg (West Germany).
PROTON–PROTON INTERACTIONS AT 10 GeV/c
S. P. Almeida (Cavendish Lab.), J. G. Rushbrooke (Cavendish Lab.), J. H. Scharenguivel (Cavendish Lab.), M. Behrens, V. Blobel et al May 1968 72 p refs
(DESY-68/17)

About 3700 two-prong and 5600 four-prong events of 10 GeV/c pp interactions in the 81-cm hydrogen bubble chamber were analyzed using Monte-Carlo generated events. The cm angular distributions and the mean values of the transverse momentum for all final-state particles are discussed. Production of Δ^{++} (1236) accounts for about 30% of the cross section $\sigma(pp \rightarrow pn\pi^+) = (4.1 \pm 0.4)$ mb. About 50% of the cross section $\sigma(pp \rightarrow pp\pi^+\pi^-) = (2.4 \pm 0.2)$ mb can be accounted for by Δ^{++} production. Production of nucleon isobars at 1450, 1520, and 1730 MeV and their subsequent decay into $p\pi^+\pi^-$ are investigated. Their cross sections, t-dependences and branching ratios are determined, using a one-pion exchange model (OPEM) for calculating the background distributions. The production of resonances decaying into $p\pi^-$ at 1236, 1500, and 1690 MeV is seen, and cross sections are given. Resonance production in the $pp\pi^+\pi^-\pi^0$ and $pn\pi^+\pi^+\pi^-$ reactions are studied using background curves based on simple parameterizations of the cm momentum distributions. The production of nucleon isobars accounts for nearly 100% of these reactions. It is shown that most of the cross features of the pion production reactions can be explained by the OPEM with the form factors of Ferrari and Selleri. Author (NSA)

N68-34276# International Centre for Theoretical Physics, Trieste (Italy).
DETERMINATION OF THE PION AND CONSPIRATOR RESIDUES AND TRAJECTORIES IN POSITIVE PION PHOTOPRODUCTION FROM CONTINUOUS MOMENT SUM RULES
P. Di Vecchia (Lab. Nazl. di Frascati del CNEN), F. Drago (Lab. Nazl. di Frascati del CNEN), C. Ferro Fontan, R. Odorico (Trieste Univ.), and M. L. Paciello (Rome Univ.) May 1968 10 p refs
(IC-68/40)

Using continuous moment sum rules clear evidence is obtained for the pion conspiracy. The pion and conspirator residues and trajectories which reproduce with accuracy the forward peak in the high-energy differential cross section are found. Author (NSA)

N68-34303# Stanford Univ., Calif. Linear Accelerator Center.
THEORY OF MONITORS OF SECONDARY ELECTRON EMISSION
G. G. Bakhshyan and G. M. Garibyan [1967] 36 p refs Transl. into ENGLISH from Izv. Akad. Nauk Arm. SSR, Ser. Fiz., v. 2, 1967 p 415-432
(SLAC-TRANS-85) CFSTI: HC$3.00/MF$0.65

A theoretical analysis is made of the operation of monitors of secondary electron emission in a case in which the primary particle is extremely relativistic. It is shown that in the operation

of the monitor an essential role is played by the oxide layer that forms on the surface of the metal emitter. If a strong electric field is created in that layer, the secondary-emission current will be dependent on the energy of the primary particles. A qualitative discussion of the influence of a strong electric field on the process of formation of the latent image in the photoemulsion and on de-excitation of the scintillators is presented. Sixty-three references are included. Author (NSA)

N68-34305# Sandia Corp., Albuquerque, N. Mex.
ANALYTICAL EXPRESSIONS FOR BREMSSTRAHLUNG SPECTRA EMITTED BY HIGHLY FILTERED, THICK HIGH-Z TARGETED X-RAY DEVICES FROM 2 TO 20 MeV
J. C. Golden, Jr. Apr. 1968 14 p Presented at the 13th Ann. Health Phys. Soc. Meeting, Denver
(Contract AT(29-1)-789)
(SC-DC-67-2399; CONF-680607-7) CFSTI: HC $3.00/MF $0.65

An analytical model for bremsstrahlung spectra is presented. Expressions are developed which provide a method for estimating the magnitude of the flux density, intensity, and exposure rate spectra from high-energy X-ray devices, with high Z targeted material such as tungsten and of such target thickness that scattering and energy loss processes appreciably influence bremsstrahlung production. The maximum kinetic energy of the electrons may be as high as 20 MeV. NSA

N68-34317*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
ELECTRON IMPACT IONIZATION ON H(2s) AND H(2p)
H. Lee Kyle and K. Omidvar Aug. 1968 40 p refs Revised
(NASA-TM-X-63143; X-641-68-90) CFSTI: HC $3.00/MF $0.65
CSCL 20H

Cross sections for the ionization of the first excited levels of atomic hydrogen have been calculated using two quite different theories. The Born exchange approximation and the Vainshtein binary collision approximation. In the Born exchange calculation Prasad's (2s → c) cross sections are confirmed and it is found that positive interference occurs for (2pm = ±1→c) cross sections in the Born exchange (i) approximation. The binary collision approximation would appear to yield rather poor results in this case. This theory is formulated in some detail and the approximations carefully pointed out. Author

N68-34319# European Atomic Energy Community, Geel (Belgium). Central Bureau for Nuclear Measurements.
EVALUATION OF THE BORON 10 (NEUTRON, ALPHA) CROSS SECTION AND BRANCHING RATIO
K. Gubernator and H. Moret Brussels Jun. 1968 39 p refs
(EUR-3950.e)

Data avilable on the ^{10}B (n,α) cross section and the branching ratio in the range from thermal energy to 1 MeV are compiled. After a critical evaluation a set of data is selected to compute recommended values and best curves of the (n,α) cross section and the branching ratio, for neutron energies up to 100 keV. The σ_{n,α_1} cross section is derived from this. At thermal energy $\sigma_{n,\alpha_1} = (3835 \pm 14)$b and $R = 6.308 \pm 0.012$ are recommended, the errors corresponding to confidence limits 95%). From thermal energy to 100 keV best curves are recommended on the basis of least squares fits to the experimental data. The formula for $\sigma_{n,\alpha}$ $=f(E)$ contains terms to correct for non-1/v behavior from the eV-range up to 100 keV. The confidence interval gradually decreases from ± 14b (thermal) to ± 0.08 b (100 keV). R = constant = 6.3 ± 0.3 up to 30 keV. From 30 to 100 keV higher order terms are proposed to fit the data. All recommended values and curves are summarized in the last chapter of this report, together with a set of numerical values. Author

N68-34320# European Organization for Nuclear Research, Geneva (Switzerland).
DETERMINATION OF PARTICLE SCATTERING AMPLITUDES FROM NUCLEAR PHOTOPRODUCTION
J. Formanek and J. S. Trefil 20 Sep. 1967 26 p refs Supported in part by AFOSR
(NP-17497)

Recent work on the extraction of resonance nucleon scattering amplitudes from the cross section for the production of resonances from helium is extended to include photoproduction and also to include heavier target nuclei. It is found that the reactions $\gamma + {}^4He \rightarrow \rho^0 + {}^4He$ and $\gamma + {}^{16}O \rightarrow \rho^0 + {}^{16}O$ the rho–nucleon scattering amplitude can be deduced, provided that the energy resolution of the experiment is good enough to fix the final state of the nucleus unambiguously. Author (NSA)

N68-34328 Pennsylvania Univ., Philadelphia.
MEASUREMENT OF THE BRANCHING RATIOS OF $K^+_{\mu 2}$, $K^+_{\pi 2}$, $K_{\iota 3}$ AND $K^+_{\pi 3}$
John MacGregor Dobbs (Ph.D. Thesis) 1967 76 p
Available from Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-12740

An experiment at the Princeton-Pennsylvania Accelerator with scintillation counters and spark chambers determined the branching ratios for the K+ decay modes $K^+_{\mu 2}$, $K^+_{\pi 2}$, $K^+_{\mu 3}$ and $K^+_{\iota 3}$. For each event, the momentum and range of the charged secondary and the time interval between the arrival of the K+ and its decay were measured. The momentum was measured in thin foil spark chambers placed in a magnetic field. The range was then measured in a thick-plate spark chamber in which all charged products from K+ decay were stopped. K+ decays-in-flight were eliminated through use of the timing information. The solid angle and detection efficiency of the apparatus were constant over the momentum interval 130 to 260 MeV/c. Based on approximately 23,000 measured events, the values for the branching ratios were determined by using for the τ and τ' branching ratios (5.58 ± 0.08)% and (1.70 ± 0.055)%, respectively. A table of weighted averages of all K+ branching ratio measurements is included. Dissert Abstr.

N68-34336# California Univ., Berkeley. Lawrence Radiation Lab.
RADIOFREQUENCY RESONANCES IN MERCURY AND NEON ATOMS EXCITED BY ELECTRON IMPACT
Orilla Ann McHarris (Ph.D. Thesis) 24 May 1968 85 p refs
(Contract W-7405-ENG-48)
(UCRL-18178) CFSTI: HC $3.00/MF $0.65

Dehmelt's technique of producing and aligning an excited atomic state by electron bombardment and then detecting an rf resonance of the state by optical means was applied to neon for the first time. The metastable $(2^2P_{3/2}3^2S_{1/2})_2$ state was produced by collision with electrons of about 25 eV, and the resonance was detected as a change in absorption of the 6143 Å resonance radiation corresponding to a transition from the metastable state to the higher $(2^2P_{3/2}3^2S_{1/2})_2$ state. The measured g_J value agrees with that given by the atomic beam method. The magnetic field was calibrated with the rf resonance of the mercury 6^3P_2 state; this state was also produced and aligned by electron impact, and the resonance was detected as a change in absorption of the resonance radiation to the 7^3S_1 state. In a further application of this technique, the lifetime of the mercury 6^3P_2 magnetic sublevels was obtained (as a function of the pressure of the mercury vapor). The equation for the rf resonance line was derived, and with the use of the equation the m-state lifetime was obtained both from the variation of the line width with rf power and also from the separation of the two maxima in the strongly rf-broadened line. For pressures of 4 to 7 × 10⁻³ torr the lifetime was found to be 1 to 0.5 × 10⁻⁶ sec. These values are similar to those obtained by Baumann, although in order to agree with the equation for the resonance line, his values should be multiplied by a factor of 2. The relationship of the lifetime to the most likely collision processes is discussed. Author (NSA)

N68-34340# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
NEW ^{136}Nd ISOTOPE AND ITS DECAY PRODUCTS [NOVYI IZOTOP ^{136}Nd I PRODUKTY EGO RASPADA]
Zh. Zhelev, V. G. Kalinnikov, Ya. Liptak, and L. K. Peker 1968 21 p refs In RUSSIAN
(JINR-P6-3823)

The previously unknown isotope ^{136}Nd ($T_{1/2}$ = 55 ± 1.5 min) was identified. The positron, γ-ray, and conversion electron spectra of the decay chain of ^{136}Nd → ^{136}Pr → ^{136}Ce were investigated. The multipolarities of a number of transitions were determined. The scheme of the ^{136}Pr and ^{136}Ce excited levels is suggested. The characteristics 1+ are ascribed to the 108.8-keV ^{136}Pr level, while the characteristics 2+ are ascribed to the ground state ($T_{1/2}$ = 13.5 min). The ^{136}Ce levels with the energies 551.5, and 1090.4 keV have characteristics 2^+ while those of the 1551.3-keV level are I^{π} = 3^+. Possible quantum characteristics and other ^{136}Ce levels are estimated by comparing the spectra of even-even states containing 78 neutrons.
Author (NSA)

N68-34343# California Univ., Berkeley. Lawrence Radiation Lab.
AN INVESTIGATION OF THE (He-3,t) AND (He-3, He-3') REACTIONS ON 1p SHELL NUCLEI
Gordon Charles Ball (Ph.D. Thesis) May 1968 143 p refs
(Contract W-7405-ENG-48)
(UCRL-18263) CFSTI: HC$3.00/MF$0.65

The (3He,t) and (3He') reactions on ^{9}Be, ^{12}C, ^{13}C, ^{14}C [(3He,t) reaction only], ^{14}N, and ^{15}N were investigated at ^{3}He energies of 39.9, 49.8, 39.6, 44.8, 44.6, and 39.8 MeV, respectively. Angular distributions were obtained for all prominent states up to excitations of 20 MeV. A microscopic analysis of these data was carried out using a local two-body interaction with an arbitrary spin-isospin exchange mixture. Spectroscopic factors were calculated using intermediate-coupling wave functions for p shell states while simple j–j configurations were assumed for the levels which were populated by promoting a p nucleon to the s–d shell. A Yukawa interaction with a range of α^{-1} = 1.2 F was found to give the best results. The strength of the effective nucleon–nucleon interaction required to fit these data is in good agreement with recent (p,p'), (p,n) and (3He,t) calculations on light nuclei.
Author (NSA)

N68-34357# Reactor Centrum Nederland, Petten.
DIRECT OBSERVATION OF DAMAGE IN NEUTRON IRRADIATED VANADIUM
J. D. Elen Dec. 1967 42 p refs
(RCN-96) CFSTI: HC$3.00/MF$0.65

Irradiation of commercial V at ca. 80° to a fast neutron dose of 7.4·10^{19} n/cm^2, results in a high density of arrays of presumably interstitial clusters of about 70A. There is evidence of a denser homogeneous distribution of separated small dots near the resolution of the microscope. These are probably depleted zones. 0.1 Micron wide denuded zones along grain boundaries are explained in terms of interstitial migration. After annealing at 400-600°C large [111] 1/2 a (111) vacancy loops are formed, which at 700°C anneal out within one hour.
Author (ESRO)

N68-34376# California Univ., Livermore. Lawrence Radiation Lab.
(P,p) AND (n,p) DATA LISTING 0–750 MeV
Malcolm H. MacGregor, Richard A. Arndt, and Robert M. Wright 15 Apr. 1968 87 p refs
(Contract W-7405-eng-48)
(UCRL-50426) CFSTI: HC$3.00/MF$0.65

This report gives the computer listings for the (p,p) and (n,p) scattering data (papers VII, VIII, and IX of series on "Determination of the Nucleon–Nucleon Scattering Matrix," the Physical Review). Also included are the references for these data, as used in Table II of papers VII–IX. In a few cases, newer versions of the data were included as described in footnotes. The phase shift analyses included all of the known reliable data as of July 1967. Some updating of these data as of April 1968 is given.
Author (NSA)

N68-34412# Oak Ridge National Lab., Tenn.
A COMPUTER-AIDED STUDY OF A 600 MHZ DECADE SCALING SYSTEM
Edward Kyle Reedy (Ph.D. Thesis) Aug. 1968 197 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2214) CFSTI: HC$3.00/MF$0.65

The primary objective of this study was to survey, evaluate, and compare the high-speed properties of existing scaling techniques to determine the feasibility of building a completely transistorized counting or scaling system capable of accepting and correctly handling input signals having fixed frequency or equivalent aperiodic repetition rates above 500 MHz. An auxiliary or secondary objective of this study was to illustrate the application of generalized circuit analysis computer programs in a high-speed circuit design problem. A comprehensive examination of several direct scaling techniques, with particular emphasis placed on the high-frequency limitations inherent in each technique, indicated that the maximum overall scaling rate for all circuits considered, with the exception of the twisted ring and Engelmann, was limited to the maximum scaling rate of the first binary stage in the system. Conflicting input pulse requirements (high pulse energy coupled with narrow width) forced the exclusion of the twisted ring scheme from further consideration.
Author (NSA)

N68-34413# Oak Ridge National Lab., Tenn.
THE N^{14}(n,nγ) REACTION FOR 5.8 ≤ En ≤ 8.8 MeV
J. K. Dickens, E. Eichler, F. G. Perey, P. H. Stelson, John Ashe et al 21 Jun. 1968 25 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2267) CFSTI: HC$3.00/MF$0.65

Gamma ray spectra for the reactions ^{14}N(n,n'γ)^{14}N, ^{14}N(n,pγ_1)^{14}C and ^{14}N(n,$\alpha\gamma$)^{11}B for incident mean neutron energies E_n = 5.8, 6.4, 6.9, 7.4, 8.0, and 8.6 MeV were obtained. The gamma rays were detected using a coaxial Ge(Li) detector of 30 cc active volume. The detector was placed at 55° and 90° with respect to the incident neutron direction, and was 77 cm from the sample; time-of-flight was used with the gamma ray detector to discriminate against pulses due to neutrons and background gamma radiation. The sample was 100 gm of Be_3N_2 in the form of a right circular cylinder. Data were also obtained using 75-gm Be sample to provide an estimate of the background. The incident neutron beam was produced by bombarding a deuterium-filled gas cell with the pulsed deuteron beam of appropriate energy from the ORNL 6-MV Van de Graaff. These data were studied to obtain absolute cross sections for production of gamma rays from ^{14}N for the incident neutron energies quoted above.
Author (NSA)

N68-34414# Los Alamos Scientific Lab., N. Mex.
AUTOMATIC CONTROL OF RF AMPLIFIER SYSTEMS
R. A. Jameson 1968 10 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y. Sponsored by AEC
(LA-DC-9445; CONF-680515-11) CFSTI: HC$3.00/MF$0.65

Development of the rf control system for the LAMPF linac is discussed. Prototype versions of all hardware are operating in the electron prototype accelerator system and have been used for testing the design approach. Measurements are being made to investigate system interactions, nonlinearities, and second-order effects as the basis for final design.
NSA

N68-34434# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
THE TOTAL NEUTRON CROSS SECTION OF ^{230}TH AT THE THERMAL ENERGY REGION [POLNOE NEITRONNOE SECHENIE TORIYA-230 V TEPLOVOI OBLASTI ENERGII]

S. M. Kalabin, P. N. Palei, R. N. Ivanov, Z. K. Karalova, G. M. Kukavadze et al 1967 14 p refs In RUSSIAN
(ITEF-546)

One gram of the purified ^{230}Th was chemically educed from uranic ore. The purity of the sample prepared was established by means of a mass-spectrometric analysis. Neutron cross sections were measured at 0.0141 to 1.0 eV. It was shown that the neutron cross section of ^{230}Th in the thermal region has neutron resonance levels close to the thermal energy. In particular, there exists a negative level with energy close to zero. At the thermal point (E = 0.025 eV), the total cross section of ^{230}Th is 70 ± 3.8 barn. It is also shown that when measuring with new samples of $^{230}_{90}Th$ in the wider energy region, the levels with the energies E = 1.107, 2.390, and 7.80 eV were not obtained.
Author (NSA)

N68-34436# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
RESONANCE SCATTERING OF GAMMA RAYS OF ^{191}Ir WITH ENERGY OF 129 keV [REZONANSNOE RASSEYANIE GAMMA-LUCHEI ^{191}Ir S ENERGIEI 129 keV]
A. V. Davydov, G. R. Kartashov, and Yu. V. Khrudev 1967 24 p refs In RUSSIAN
(ITEF-X-529)

The angular distribution of 129-keV gamma rays resonantly scattered by ^{191}Ir nuclei (Moessbauer effect) was measured. These data were used in determining the magnetic moment of the ^{191}Ir excited state with the energy of 129 keV. The experiment consisted in the measurement of the rotation angle of the scattered radiation angular distribution in the magnetic field of ±24.5 kOe. The measured value of the magnetic moment was 3.00 ± 0.58 nm. At the same time the multipole mixing parameter was determined for the 129-keV transition to be $\delta = +0.398 \pm 0.20$. Author (NSA)

N68-34438# Rome Univ. (Italy).
PROPOSAL FOR AN EXPERIMENT FOR THE MEASUREMENT OF THE COLLISION CROSS SECTION FOR PHOTOPRODUCTION OF NEGATIVE PIONS BY NEUTRONS IN DEUTERIUM [PROPOSTA DI ESPERIENZA PER LA MISURA DELLA SEZIONE D'URTO DI FOTOPRODUZIONE DI PIONI NEGATIVI SU NEUTRONI IN DEUTERIO]
M. Beneventano, M. Dal Priori, F. de Notaristefani, P. Monacelli, L. Paoluzi et al 16 Dec. 1966 21 p refs In ITALIAN *Its* Note No. 110
(NP-17458)

An experiment is described for the measurement of the cross section of the reaction $\gamma + n \rightarrow \pi^- + p$ at fixed angle of emission of π^- in the pion-nucleon cms system for incident γ energy between 500 and 800 MeV. The kinematics of the process are calculated and the results are graphed. The experimental apparatus is sketched with emphasis on the pion and proton channels. The counting rate required is evaluated. NSA

N68-34439# Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia).
ON THE MOESSBAUER SPECTROSCOPY AND THE STUDY OF THE HYPERFINE STRUCTURE OF 14.4-keV LEVEL IN SOME IRON COMPOUNDS [OSNOVE MOESSBAUERJEVE SPEKTROSKOPIJE IN RAZISKAVE HIPERFINE STRUKTURE NIVOJA ENERGIJE 14,4 keV V NEKATERIH ZELEZNIH SPOJINAH]
D. Hanzel Dec. 1967 54 p refs In YUGOSLAV
(NIJS-P-212)

Some theoretical foundations of recoilless transitions and experimental methods for measurements of Mössbauer effect are surveyed. Special attention is paid to the measurements of hyperfine structure of the velocity spectra. The spectra were measured by a velocity spectrometer having a sinusoidal wave drive. The device was calibrated by measuring the hyperfine spectrum of ^{57}Fe in metallic iron and Fe_2O_3. Measurements of the hyperfine spectra of the 14.4-keV γ rays from ^{57}Fe in the perovskite type compounds $BiFeO_3$ and $LaFeO_3$ were performed using powdered samples at different temperatures. Above the antiferromagnetic transition point of the $BiFeO_3$ only a quadrupole splitting in the spectra was observed. Below the Neel temperature the spectra for the $BiFeO_3$ absorber showed characteristics of a combined electric and magnetic hyperfine coupling. With decreasing temperature a gradual increase of magnetic hyperfine coupling was observed. The internal magnetic field at the position of the Fe nucleus in $LaFeO_3$ is nearly the same as in Fe_2O_3. Author (NSA)

N68-34445# Los Alamos Scientific Lab., N. Mex.
TIME-OF-FLIGHT NEUTRON CROSS-SECTION MEASUREMENTS MADE WITH NEUTRONS FROM NUCLEAR EXPLOSIONS
A. Hemmendinger, B. C. Diven, W. K. Brown, A. Ellis, E. R. Shunk et al 18 Jun. 1968 26 p refs
(Contract W-7405-eng-36)
(LA-3478, Pt. 1) CFSTI: HC $3.00/MF $0.65

Well-known laboratory techniques have been adapted to meet the specific requirements of neutron time-of-flight measurements using as a source the neutrons emitted in a nuclear detonation. The experimental arrangements and hardware are described, with particular attention to parameters affecting neutron flux and energy resolution. Details of instrumentation and data recording schemes are presented. Author (NSA)

N68-34461# General Electric Co., Cincinnati, Ohio. Missile and Space Div.
PROGRAM (TNDT (NS0896): A CODE TO PREPARE A 16-GROUP NUCLEAR DATA TAPE FOR TRANSPORT CODES DTF-4 AND 2DF
W. B. Henderson and C. S. Robertson, Jr. 6 Jun. 1968 28 p refs
(Contract AT(40-1)-2847)
(GEMP-617) CFSTI: HC $3.00/MF $0.65

The program TNDT (NS0896), a FORTRAN-IV code which prepares a 16-group nuclear data tape for use by the DTF-IV and 2DF transport codes, is described. The data for an isotope, element, or material, on cards in one of four allowed formats, are put on the new tape together with selected data from an existing tape. In addition to tape listings, punched cards can be requested containing the 16-group cross sections for any mixture of tape species weighted by density and group effective "g" factors. The punched cards can be used directly as input to the transport codes or for addition to the tape. Author (NSA)

N68-34473# California Univ., Berkeley. Lawrence Radiation Lab.
EFFECT OF THE EXISTENCE OF AN ELEMENTARY QUARK ON HIGH-ENERGY SCATTERING
Stuart D. Anderson (Ph.D. Thesis) 17 May 1968 43 p refs
(Contract W-7405-eng-48)
(UCRL-18251) CFSTI: HC $3.00/MF $0.65

An elementary quark, if supposed to exist and to couple in quark–antiquark pairs to ordinary two-particle channels, gives rise to a Regge trajectory which would dominate high energy scattering at large momentum transfer. A simple model theory embodying these features is presented. Specifically, the model assumes a single scalar–scalar pair to represent the ordinary two particle channel which is observed, coupled to a spinor–spinor channel of large mass and simple pole type potentials and subtraction generated by this coupling are computed, and arguments given concerning their contribution to the cross section. Comparison with proton–proton scattering suggests that if such an elementary particle exists, its mass must be greater than about 10 GeV.
Author (NSA)

N68-34475# United Kingdom Atomic Energy Authority, Harwell (England). Nuclear Physics Div.

THE AVERAGE NEUTRON TOTAL CROSS-SECTION OF B-10 FROM 100 eV TO 10 MeV AND ABSORPTION CROSS-SECTION UP TO 500 keV

K. M. Diment Feb. 1967 17 p refs

(AERE-R-5224) CFSTI: HC $3.00/MF $0.65

The transmission measurements to be described were made on the 120 m and 300 m flight paths of the Electron Linac time of flight spectrometer at Harwell. Analysis of the total cross section below 10 keV shows $\sigma_{n,T} = (610.3 \pm 3.0)\ E^{-1/2} + (1.95 \pm 0.10)$ barns. The deviation of $\sigma_{n,T}$ from this value above 40 keV is due to an increase in elastic scattering cross section. Subtraction of the latest scattering cross sections measured by Mooring et al yields an absorption cross section that is proportional to $E^{-1/2}$ up to at least 250 keV. Author (NSA)

N68-34482# Forsvarets Forskningsanstalt, Stockholm (Sweden).

CALCULATION OF FUSION REACTION RATES USING AVERAGES OVER DEFORMED MAXWELLIAN DISTRIBUTIONS

N. Hoernqvist May 1968 22 p refs

(FOA-4-4360-25)

Calculations are reported of fusion reaction rates with averages over the particle velocity distributions involved. Usually Maxwellian distributions were employed. The distribution function is assumed to be a Maxwellian with a deformation, simulating e.g., an energy peak. The relative effect of this deformation on the magnitude of the fusion reaction rate was investigated. The calculations were restricted to the case of fusion between deuterons and tritons. Author (NSA)

N68-34488# Princeton Univ., N. J. Palmer Physical Lab.

GROUPS, SYMMETRIES AND QUARKS. PART 2: QUARKS

Harry J. Lipkin Jun. 1968 44 p refs Supported in part by the Higgins Sci. Trust Fund

(Contract AT(30-1)-937)

(PUC-937-324) CFSTI: HC $3.00/MF $0.65

A general description of the present state of the quark model is reviewed. The algebriac structure of the quark model, the group U(6) × U(6) and its subgroups, three point functions in the quark model, and the properties and types of quarks are discussed. NSA

N68-34490# Electrotechnical Lab., Tokyo (Japan).

ABSOLUTE MEASUREMENTS OF HIGH ENERGY X-RAY BEAM ENERGY AND PHOTONEUTRON CROSS SECTIONS FOR NATURAL COPPER AND LEAD

Takio Tomimasu Dec. 1967 59 p refs

(Rept.-679) CFSTI: HC $3.00/MF $0.65

Consideration is given to the absolute determination of high energy X-ray beam energy by cavity ionization chamber method, and the determination of absolute photoneutron cross sections of natural copper and lead with an ETL quantameter and a 4 neutron detector using the X-ray beam from an ETL 25 MeV betatron. The cavity chamber theory for measurement of high energy photon beam is described, and the stopping power ratios for use with the cavity ionization chamber are given. Attention is also given to the design and calibration of quantameter which has good accuracy when used in wide energy ranges. The theoretical calibration of the quantameter is given and compared with recent experimental data obtained from the calibration of other type quantameters. The results of the investigation are discussed in relation to backscattered energy and lateral and longitudinal distributions of energy losses in the shower, and leakage energy due to radiation losses and photonuclear reactions. B.S.D.

N68-34511# Los Alamos Scientific Lab., N. Mex.

DOUBLE-DRIFT BUNCHER

C. Robert Emigh 1967 26 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y. Sponsored by AEC

(LA-DC-9422; CONF-680515-7) CFSTI: HC $3.00/MF $0.65

A proposed double drift buncher for bunching a proton beam for acceptance into a linac is described. The drift space between two rf acceleration gaps and the drift space between the second rf acceleration gap and the linac are utilized to reduce beam loss. Space chase effects are considered. NSA

N68-34513# Los Alamos Scientific Lab., N. Mex.

THE LASL HIGH-DUTY-FACTOR ION SOURCE

C. R. Emigh and Donald W. Mueller 1968 14 p refs Presented at the Conf. on Proton Linear Accelerators, Upton, N. Y. Sponsored by AEC

(LA-DC-9421; CONF-680515-6) CFSTI: HC $3.00/MF $0.65

A description of the design and performance of the duoplasmatron proton ion source for the LAMPF accelerator is presented. The performance of the vacuum system, magnet coils, cooling-water system, ion source insulating ring, intermediate electrode, and the pulser system is described. Some results of 12 percent duty factor operation are also presented. NSA

N68-34516# California Univ., Berkeley. Lawrence Radiation Lab.

PROTON-He-3 POLARIZATION IN THE RANGE FROM 10 TO 20 MeV

William F. Tivol (Ph.D. Thesis) Apr. 1968 87 p refs

(Contract W-7405-ENG-48)

(UCRL-18137) CFSTI: HC $3.00/MF $0.65

Using the polarized beam facility of the 88 inch isochronous cyclotron at Berkeley, the polarization of protons in the elastic scattering of polarized protons on ^3He was investigated. Four pairs of detectors were arranged around a target gas cell to count protons. These consisted of phototubes on which were mounted CsI crystals ground to a thickness approximately 50% greater than the range calculated for the protons. The signals from the detectors were routed into two 400 channel pulse height analyzers thereby separating the elastic peak from inelastic background. Backgrounds were low enough to permit an unambiguous treatment of the spectra. A solenoid magnet was used to flip the protons' spins in order to cancel any geometric asymmetries. The target gas cell was operated at 60 psi with a window of 1.9 mil dural for the higher energies, and at 20 psi with a 1 mil dural window at lower energies. Polarization as a function of angle for approximately twenty points was obtained for each of five energies in the range from 10 to 20 MeV by measuring the right left asymmetry in the differential cross section. Author (NSA)

N68-34555# Gulf General Atomic, San Diego, Calif. General Atomic Div.

COMPARISON OF DISCRETE ORDINATES CALCULATIONS WITH MEASURED NEUTRON SPECTRA IN STANDARD SHIELD GEOMETRIES

A. E. Profio 8 Aug. 1967 11 p refs

(Contracts AF 29(601)-6720; DA-49-146-XZ-482)

(AD-672225)

The anisotropic discrete ordinates code GAPLSN, its down-scattering-only version GGSN, and the newer 1DF version of the DTF-IV code were used to analyze most of the spatially-dependent neutron spectrum experiments at the General Atomic Linear Accelerator. The neutron spectrum was measured by the pulsed-source, time-of-flight method with an accuracy of about plus or minus 10% and an energy resolution of 2% or better below 1 MeV, rising to 8% at 15 MeV. Author (TAB)

N68-34581# Los Alamos Scientific Lab., N. Mex.
THE MULTISPHERE NEUTRON MONITORING TECHNIQUE
Dale E. Hankins 7 Jun. 1968 31 p refs
(Contract W-7405-eng-36)
(LA-3700) CFSTI: HC $3.00/MF $0.65

The multisphere technique is described for converting to dose equivalent the data obtained from the Bonner-sphere neutron detector. The responses from the various sizes of detector are illustrated with data obtained from several sources and critical assemblies. The theory and principles involved in converting these responses to dose equivalent are explained in detail. The multisphere technique is revised to include new calculated response curves which replace the previously used extrapolations in the intermediate-energy region. The accuracy of the technique for an intermediate-energy neutron spectrum which does not follow the 1/E distribution is evaluated. The multisphere technique described does not require a computer analysis. Author (NSA)

N68-34584# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
NUCLEAR RADIATION INDUCED CURRENTS IN COAXIAL SIGNAL CABLES
J. L. Stringer and R. R. Bourassa Jun. 1968 54 p refs
(Contract AT(45-1)-1830)
(BNWL-749) CFSTI: HC $3.00/MF $0.65

A qualitative model parametrically relating the nuclear radiation induced current in a coaxial cable to the cable materials, dimensions, and radiation flux intensity has been developed. The model will predict induced current polarities for each component of the nuclear radiation field. Experimental data indicating induced currents per unit length up to 4×10^{-8} A/cm as measured in a 0.250 in. OD coaxial cable placed in a TRIGA reactor are presented. The change in polarity of the induced current found in these experiments is described by the model. An interpretation based on this model is presented for other previously unexplained experimental data. Author (NSA)

N68-34585# California Univ., Berkeley. Lawrence Radiation Lab.
REGGE-POLE FORMALISM FOR PIONIC DISINTEGRATION OF DEUTERON
Huan Lee (Ph.D. Thesis) 20 May 1968 50 p refs
(Contract W-7405-eng-48)
(UCRL-18252) CFSTI: HC $3.00/MF $0.65

The reaction $\pi^+ + d \rightarrow p + p$ is investigated within the framework of Regge pole theory. Reggeization of the amplitudes for this process is carried out in detail, and the asymptotic behavior of the helicity amplitudes at zero momentum transfer is discussed. By assuming that the lowest anomalous threshold singularity in the t-channel dominates in the nearby region, the nucleon-deuteron Regge residue is calculated in terms of the pion–nucleon Regge residue. Also the relations of various low-energy models used to study this reaction and its inverse to the Regge pole formalism are discussed. Author (NSA)

N68-34588# Tracerlab, Inc., Richmond, Calif.
FINAL REPORT OF STUDIES OF ^{238}Pu DEBRIS PARTICLES FROM THE SNAP-9A SATELLITE FAILURE OF 1964
Walter D. Holland 27 May 1968 44 p refs
(Contract AT(30-1)-3803)
(TLW-6006; TLW-3803-1) CFSTI: HC $3.00/MF $0.65

A study was conducted on ablated ^{238}Pu particles from the SNAP-9A satellite failure of April, 1964, to provide data for the evaluation of the satellite reentry burnup hazard. Two new techniques were developed: the thick-nuclear emulsion method for viewing the alpha tracks produced by alpha-emitting particles in LTA-ashed IPC paper; and the photoreversal technique for electron microscopy of submicron radioactive particles. The size distribution of the ^{238}Pu particles after a one-month exposure in nuclear emulsion appears lognormal with a mode at ≈13 mμ (particle diameter) and a size range of ≈10 to 40 mμ. Scanning the sample slides after a one-year exposure confirmed the presence of many ^{238}Pu particles less than 10 mμ in diameter which were not seen in the one-month exposures. The contribution of Pu particles in the two- to five-track star region of the one-year-exposed samples is still unknown. Scanning slides with ^{238}Pu particles covered by nuclear emulsion also revealed that partial leaching (or dissolving) of these particles was occurring during the exposure period. A study of this effect indicated that as the equivalent $^{238}PuO_2$ particle diameter decreases, the percentage of the original particle leached increases. Since photoreversed particles were remaining on the microscope slides during float-off, three more efficient techniques for preparing these particles for electron microscopy were developed. Author (NSA)

N68-34591# California Univ., Berkeley. Lawrence Radiation Lab.
PHASE CONTOURS OF SCATTERING AMPLITUDES
Chung-I Tan (Ph.D. Thesis) 10 May 1968 76 p refs
(Contract W-7405-ENG-48)
(UCRL-18243) CFSTI: HC $3.00/MF $0.65

Phase contours are used to study consistency conditions for a symmetric scattering amplitude having a given high-energy behavior. The latter is taken to correspond to dominance by Regge poles that have continuously rising trajectories. By means of crossing symmetry a sequence of real zeros of the amplitude, that lie along lines of symmetry in the model are introduced $s = u$, in $t < 0$, for example. The leading zero in this sequence is related to the scattering length. Under quite general conditions these zeros may be related, via complex surfaces of zeros, to the zeros of Regge residues below threshold. By considering complex sections of phase contour surfaces, it is shown that these zeros may also be related to a sequence of zeros at complex points, that are due to interference between resonance poles on unphysical sheets above threshold. Author (NSA)

N68-34597# Australian National Univ., Canberra. Research School of Physical Sciences.
BRANCHING RATIOS OF Al-27 BOUND STATES
R. V. Elliott, T. R. Ophel, and R. H. Spear [1968] 16 p refs
(ANU-P-408)

A 12.7 cm × 10.2 cm NaI(Tl) gamma-ray spectrometer was used in conjunction with a 61-cm magnetic particle spectrometer to measure gamma-ray branching ratios for bound states of ^{27}Al at excitation energies of 2.21, 2.73, 2.98, 3.00, 3.68, 3.96, 4.05, 4.41, 4.51, and 4.58 MeV. Author (NSA)

N68-34635# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics.
DATA COMPILATION OF BARYON–BARYON INTERACTIONS. 1. PROTON–PROTON COLLISIONS BETWEEN 1 AND 32 GeV/c
G. Alexander, O. Benary and U. Maor 31 Oct. 1967 45 p

A review of the properties of proton–proton interactions is presented. A lower limit of 1 GeV/c is placed on the incident proton momentum. Also restriction is made to more basic experimental information, and the rarer type of data such as meson resonance production is omitted. A list of references, curves showing the total and elastic proton–proton cross sections as a function of incident momentum, differential elastic cross sections and polarization curves for various proton incident momenta, and tables for some partial reaction cross sections are given. Data published during the period January 1, 1954, to October 31, 1967 are covered. NSA

N68-34641# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
CALCULATION OF SUCCESSIVE PARTICLE EMISSION BY HIGHLY EXCITED NUCLEUS WITH A LARGE ANGULAR

MOMENTUM [RASCHET POSLEDOVATEL'NOGO ISPUSKANIYA CHASTITS VYSOKOVOZBUZHDENNYM YADROM S BOL'SHIM UGLOVYM MOMENTOM]
A. S. Il'inov and V. D. Toneev 1968 21 p refs In RUSSIAN
(JINR-P4-3814)

The behavior of a highly excited nucleus, produced in the interaction of a heavy ion with a target nucleus, was studied. The calculation was made by the Monte Carlo method. Several nuclear reactions were considered, and various interaction characteristics were compared with experiment. The effect of the model parameters on these characteristics was investigated. Author (NSA)

N68-34642# Brookhaven National Lab., Upton, N. Y.
CLASSICAL DIFFERENTIAL CROSS SECTIONS FOR SCATTERING FROM AN INVERSE POWER POTENTIAL
R. M. Felder Jun. 1968 14 p refs Sponsored by AEC
(BNL-50102) CFSTI: HC $3.00/MF $0.65

Classical differential cross sections are calculated numerically for scattering from an inverse power potential $V(r) = K/r^s$. Analytical approximations are introduced which increase the efficiency of the computation severalfold, without decreasing the precision of the results. Tables of results for selected values of the exponent s are given, as are FORTRAN programs that generate cross sections for arbitrary values of s. Author (NSA)

N68-34644# Los Alamos Scientific Lab., N. Mex.
EXPERIMENTS WITH MESONS AT ENERGIES BELOW 1 BeV: A BIBLIOGRAPHY
Betty S. Jackson, comp. 12 Jun. 1968 195 p refs
(Contract W-7405-ENG-36)
(LA-3946-MS) CFSTI: HC $3.00/MF $0.65

A bibliography of abstracts on meson interactions at energies below 1 GeV is presented. These abstracts were taken from Nuclear Science Abstracts. Volumes for the years 1959 through 1966 were searched. Though restriction is made to experiments, abstracts of largely theoretical works are included when it is indicated that experiments are performed to validate the theory or when it is not clear from the abstract whether the paper is theoretical or experimental. A permuted index is also given. NSA

N68-34658# Rochester Univ., N. Y. Dept. of Chemistry.
NUCLEAR REACTION MECHANISMS Progress Report, 1 May 1967–1 May 1968
Marshall Blann 15 May 1968 18 p refs
(Contract AT(30-1)-3591)
(UR-3591-9) CFSTI: HC $3.00/MF $0.65

The stopping powers of heavy ions in gases were measured, and nuclear level densities of recoil nuclei from α-induced reactions on ^{197}Au, ^{51}V, and ^{90}Zr were investigated. An investigation of (p,d) and (p,t) reactions on ^{117}Sn and ^{119}Sn was initiated. Evidence of spin fractionation in the decay of highly excited compound nuclei was obtained in a study of the reactions $^{58}Ni(\alpha,\alpha pn)^{58}Co$, $^{58}Ni(\alpha,\alpha p2n)^{55}Co$, and $^{58}Ni(\alpha,3pn)^{58}Co$. The search for very neutron-deficient nuclides was continued. A series of experiments on the fusion reactions of heavy nuclei was initiated with a study of ^{32}S reactions with ^{55}Mn. Calculations of the average recoil ranges from deuteron reactions with ^{58}Ni at 20 to 60 MeV were performed. NSA

N68-34659# Oak Ridge National Lab., Tenn.
AN APPROXIMATE METHOD FOR CALCULATING A SHIELD FOR THE SCATTERED RADIATION OF ACCELERATORS
L. N. Zaitsev, L. R. Kimel', M. M. Komochkov, V. P. Sidorin, B. S. Sychev et al [1968] 20 p refs Transl. into ENGLISH from Russian Rept. no. JINR-P16-3591
(ORNL-TR-1916) CFSTI: HC $3.00/MF $0.65

An approximate method of calculation of shielding from the accelerator stray radiation of different energy groups is given. The contributions to the dose rate from the stray radiation depending on the shielding thickness, made of an ordinary concrete containing 0.35 wt % of hydrogen are determined. The components of the total dose rate from soft and hard spectra of stray radiation at the JINR synchrocyclotron hall are calculated. Author (NSA)

N68-34699# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
ELEMENT 103 OF THE PERIODIC SYSTEM
E. D. Donets, V. A. Druin, and V. L. Mikheev 1968 22 p refs
(JINR-E7-3766)

The results of work on the synthesis and the study of the properties of isotopes of element 103 are analyzed. It was concluded that the most reliable and complete data are available for the isotope $^{256}103$. The half-life of this isotope is about 35 sec and its alpha emission spectrum is complex and lies between 8.3 and 8.5 MeV. To get the same degree of unambiguity in determining the properties of other isotopes of 103, in particular of $^{257}103$, some additional experiments are needed. Author (NSA)

N68-34700# Cambridge Electron Accelerator, Mass.
MEASUREMENT OF ELECTRON g FACTOR
K. W. Robinson 16 May 1968 10 p refs
(Contract AT(30-1)-2076)
(CEAL-1042) CFSTI: HC $3.00/MF $0.65

If polarized electrons trapped in a magnetic bottle can be produced by spin-exchange collisions, it may be possible to use such electrons to measure the g factor of the electron to very high accuracy. This would be done by finding the radio frequencies which depolarize the electrons. The nature of the radio-frequency fields required is analyzed and some problems associated with the experiment are examined. Author (NSA)

N68-34701# Idaho Nuclear Corp., Idaho Falls. National Reactor Testing Station.
NEUTRON TOTAL AND ABSORPTION CROSS SECTIONS OF Pu 242
T. E. Young and S. D. Reeder Jun. 1968 85 p refs
(Contract AT(10-1)-1230)
(IN-1132) CFSTI: HC $3.00/MF $0.65

The total neutron cross section of ^{242}Pu was measured from 0.008 to 8000 eV using PuO_2 powder samples in the Materials Testing Reactor fast chopper. The data were analyzed to give the thermal absorption cross section and resonance parameters below 180 eV. The observed total neutron cross section at 0.0253 eV is 39 ± 1 b, and the effective (equivalent 1/v) thermal absorption cross section derived from the measurement is 22 ± 2b. Parameters of individual resonances below 180 eV and average parameters at higher energies give a resonance absorption integral of 1090 ± 60 b and a neutron s-wave strength function of $(0.85 \pm 0.10)10^{-4}(eV)^{-1/2}$ Author (NSA)

N68-34702# Oak Ridge National Lab., Tenn.
SENSITIVITY OF GAMMA-RAY DOSE CALCULATIONS TO THE ENERGY DEPENDENCE OF GAMMA-RAY PRODUCTION CROSS SECTIONS
R. J. Yost and M. Solomito 24 May 1968 17 p refs Presented at the 2d Conf. on Neutron Cross Sections and Tech., Washington, D. C.
(Contract W-7405-ENG-26)
(ORNL-TM-2209; CONF-680307-34) CFSTI: HC $3.00/MF $0.65

The dependence of neutron-capture gamma-ray spectra on capture-neutron energy is of particular importance in the design of optimized reactor shields. The heretofore common practice of assuming that neutron capture gamma ray spectra are invariant to neutron energy is expected to be an unacceptable approximation for a shield material exhibiting strong resonance characteristics.

The importance of adequately predicting gamma ray yields from the capture of nonthermal neutrons of a particular shield is clearly a function of (a) the relative magnitudes of thermal and nonthermal neutron capture rates in regions of the shield contributing substantially to the surface capture-gamma dose rate, (b) the magnitude of the capture-gamma dose rate as compared to other sources of gamma radiation, and (c) the extent to which the capture-gamma dose rate is sensitive to changes in the shape of the capture-gamma spectrum. Each of these questions has been investigated in detail for three SNAP 10A core-laminated tungsten-lithium hydride shield configurations. Author (NSA)

N68-34740# Illinois Univ., Urbana.
STRUCTURE OF THE ANOMALOUSLY BRIGHT ATOMIC GROUPINGS SEEN IN FIELD ION MICROGRAPHS
H. C. Tong and J. J. Gilman Jun. 1968 12 p refs Presented at the 4th Intern. Materials Symp. on the Structure and Chem. of Solid Surfaces, Berkeley, Calif.
(Contract AT(11-1)-1198)
(COO-1198-518; CONF-680611-1) CFSTI: HC $3.00/MF $0.65

The fine structures of the bright image groups along [100] zonal lines of tungsten field-ion micrograph were successfully resolved. Most of the groupings are triplets. Quadruplets and quintuplets were also found. It is suggested that each multiatomic spot is a single molecular unit bound together by the presence of the imaging field. The induced polarization energy stabilizes these units at metastable sites of relatively low coordination number. Author (NSA)

N68-34744# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
INVESTIGATIONS OF BARYON NKπ RESONANCE WITH STRANGENESS S = +1 IN THE REACTION π^-P →NKKπ WITH MOMENTUM OF THE BOMBARDING π^- MESONS 3.25 GEV/C
V. V. Vladimirskii, V. V. Grigor'ev, A. P. Grishin, I. A. Erofeev, L. V. Il'kov et al. 1967 16 p refs In RUSSIAN
(ITEF-584)

The investigation of the final state NK$\overline{K}\pi$ shows a considerable generation of Y^*_0(1520), Y^*_0(1815) and K*(892) resonances at the incident pion momentum 3.25 BeV/c. Evidence is obtained for the possible existence of the NKπ-resonances with the positive strangeness about 1.8 BeV. Author (NSA)

N68-34759# California Univ., Berkeley. Lawrence Radiation Lab.
FOUR PRONG POSITIVE PI MESON p INTERACTIONS BETWEEN 3 AND 4 GeV/c
David Gordon Brown (Ph.D. Thesis) May 1968 172 p refs
(Contract W-7405-ENG-48)
(UCRL-18254) CFSTI: HC $3.00/MF $0.65

The 72-inch hydrogen bubble chamber was exposed to a beam of π^+ mesons at incident momenta ranging from 2.95 to 4.08 GeV/c. The resulting film yielded 39,000 four-prong interactions which were processed using the FSD device and the Fog-Cloudy-Fair data reduction system. Formation of N*(2850) and production of the dominant quasi-two-body final states were investigated. In particular the double resonance channels $N^{*++}\rho^0$, $N^{*++}f^0$, $N^{*++}\omega^0$, and $N^{*++}\eta^0$ were sufficiently free from background to allow consideration of their production mechanisms as seen in their cross sections and angular distributions. One-meson-exchange models were found to account correctly for the general features of the first reaction although being inadequate to explain the fine structure of the experimental distributions. Author (NSA)

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N68-33677 Cornell Univ., Ithaca, N. Y.
THE EFFECT OF TENSOR CONDUCTIVITY ON CONTINUUM AND COLLISIONLESS MAGNETOGASDYNAMIC FLOWS
James Yue-Tak Tang (Ph.D. Thesis) 1967 70 p
Available from Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 67-13927

The steady, linearized flow of a compressible, fully-ionized gas past thin bodies in the presence of a uniform applied magnetic field aligned with the undisturbed flow is investigated. The electrical conductivity of the fluid is assumed to be tensor in character, and its magnitude such that the magnetic Reynolds number, based on the length of the body, is large. This requirement may be satisfied in two entirely different physical situations: in a dense plasma which is dominated by collisional effects, or in a diffuse collision-free plasma. Both of these cases are considered. For the first case, the set of continuum magnetogasdynamic equations is appropriate. This set of equations includes the generalized Ohm's law suitable for fully-ionized gases, and takes into account the effects of electron pressure gradients and Hall currents. For the collisionless plasma, it is possible to derive a set of self-contained hydrodynamic-like equations that form a uniformly consistent set for treating collisionless magnetogasdynamic flows with a strong magnetic field. Dissert. Abstr.

N68-33699 Northwestern Univ., Evanston, Ill.
KINETIC EQUATION WITH ELECTROMAGNETIC INTERACTION
John Thomas Hogan (Ph.D. Thesis) 1967 97 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-15244

A kinetic equation for a plasma is presented, treating the full electromagnetic interaction. The plasma is assumed spatially homogeneous and free of external fields. It is found that the shielding approximation of the BBKGY theory of Coulomb interactions has a natural analogue in this general case. Thus, the kinetic equation is derived in the plasma limit, under the adiabatic assumption, and, further, with the shielding approximation. With these restrictions the resulting equation is simpler than previous results, as desired, and is obtained in a physically more illuminating way. The result is compared to its BBKGY analogue, the Landau form of the Fokker–Planck equation, and to the more complicated exact result. Dissert. Abstr.

N68-33816 Michigan Univ., Ann Arbor.
THE ABSORPTION OF MICROWAVE RADIATION IN A SLIGHTLY IONIZED GAS
Leonard Howe Wald (Ph.D. Thesis) 1967 151 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-15718

The purpose of this investigation was to study the absorption of microwave radiation in a slightly ionized gas as a function of electron density. The microwave absorption data was provided by measurement of the absorption produced in a collimated 12 GHz microwave beam passing along the axis of a pyrex cylinder containing ionized helium. The helium was ionized by an RF electric field of 7.1 MHz. Absorption data was taken for variations in electron density over the range $.2 \leq \omega_p^2/\omega^2 \leq .6$ and for variations in helium pressure over the range $.1 \leq p(\text{mm Hg}) \leq 17$. Data were taken from both afterglow and steady-state ionized gases and

electron temperatures were taken coincidently with the steady-state absorption data by use of heated bi-polar Langmuir probes. The absorption was found to be due partially to refractive-defocussing effects, but it was possible to measure and thus correct for these effects by use of a combination of the steady-state and afterglow absorption data. Dissert. Abstr.

N68-33834*# Volt Technical Corp., Washington, D. C.
ENERGY EXCHANGE BETWEEN ELECTRON AND MOLECULAR GASES
L. M. Biberman and A. Kh. Mnatsakanyan 5 Sep. 1968 6 p refs Transl. into ENGLISH from "Electricity from MHD" Vienna, 1966
(Contract NAS5-12487)
(NASA-CR-96611; ST-GD-AC-10751) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The energy exchange between an electron gas and a molecular gas is considered, and it is shown that the exchange mechanism is essentially dependent on the composition of the latter. For a gas consisting of molecules capable of forming an unstable negative ion (N_2, CO, etc.) this process is decisive. Calculations are made of the rate of energy exchange between an electron gas and nitrogen at different temperatures of the two gases. It is shown that the rate of exchange, which is governed by this mechanism, exceeds by several orders of magnitude the corresponding value, linked with other processes, usually taken into account. Author

N68-33838*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DIAGNOSTICS AND INTERPRETATION OF ACCELERATION MECHANISMS IN AN MPD ARC
D. R. Brooks, J. M. Hoell, Jr., R. V. Hess, and P. Brockman [1967] 31 p refs Presented at the AIAA Joint Elec. Propulsion and Plasmadyn. Conf., Colorado Springs, 11–13 Sep. 1967
(NASA-TM-X-60478) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Experimental results are presented for distributions of current, potential, electron density, electron pressure, and ion velocity vector orientation in a hollow-cathode porous-anode MPD arc. The presence of electromagnetic effects is verified by the existence of large radial electric fields and axial currents extending several anode diameters downstream from the electrodes. Additional evidence is provided by observation of the conversion of ion rotational velocity into translation. A relatively large azimuthal current of unknown magnitude and distribution has been found. Electrothermal fields ($\nabla P_e/ne$) can be as large as electric fields in some regions of the arc exhaust. Despite a large number of simplifications made in analysis, numerical solutions to Laplace's equation have yielded potential surveys which agree qualitatively with experiment. Computed equipotentials are given which show the effect of cathode location and magnetic field. Author

N68-33845 Saskatchewan Univ., Saskatoon.
AN EXPERIMENTAL INVESTIGATION OF LANGMUIR PROBES
Reginald Montgomery Clements (Ph.D. Thesis) 1967 120 p
Available from Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-15421

Electron temperatures and densities measured with cylindrical double probes are compared with independent measurements of these quantities made with a gated microwave radiometer and a microwave resonant cavity respectively, in a plasma region removed from the influence of the probes. These measurements were carried out in a weakly ionized helium afterglow. Since temperatures measured with the probes are found to be reliable, the probes are used to check the radiometer at high densities (such that the plasma frequency is equal to or large compared with the frequency of radiation detected) where the radiometer is considered to be unreliable. For collisionless conditions and in the presence of a magnetic field, the temperatures measured with the probes and radiometer agreed but in the absence of a magnetic field the radiometer yielded temperatures too high (as much as a factor of about three). Possible reasons for this disagreement are discussed. Dissert. Abstr.

N68-33863*# Stevens Inst. of Tech., Hoboken, N. J.
PROPERTIES OF THE SPOKES IN COAXIAL AND PARALLEL—PLATE PLASMA ACCELERATOR
W. Prior, W. H. Bostick, L. Grunberger, P. Palmadesso, and J. Zorskie [1967] 7 p refs Presented at the Am. Phys. Soc. Topical Conf. on Pulse High-Density Plasmas, Los Alamos, N. Mex., 19–22 Sep. 1967 Submitted for publication
(Grants NsG-596; AF-AFOSR-265-67; Contract F19628-67-C-0265)
(NASA-CR-88805; SIT-208) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Image converter photographs have shown that the "spokes" produced in the plasma coaxial accelerator at 2 mm hydrogen pressure are produced in pairs. Magnetic probe measurements indicate that the spokes have roughly the magnetic structure of a quasi-force-free configuration. Although the structures are too small in diameter(1mm) to make ion-density-flow probe measurements of their profiles, there are compelling reasons to predict that these structures have mass flow patterns roughly parallel to the quasi-force-free magnetic structure. Schlieren and spectroscopic techniques for measuring ion density profiles of the vortices are described. Spectroscopic techniques for measuring rotational velocity profiles are also described. Theoretical attempts are made to understand these structures as minimum energy configurations. Author

N68-33899*# National Bureau of Standards, Washington, D. C.
SPECTRAL DISTRIBUTIONS OF TURBULENCE IN A PLASMA WITH COLLISIONAL AND COLLISIONLESS DISSIPATIONS
C. M. Tchen [1967] 47 p refs Presented at the Intern. Conf. on Ionized Gases, Vienna, 1967
(NASA Order 127)
(NASA-CR-87760) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Based on the Navier–Stokes equation of motion, the equation of continuity for a compressible fluid, and the Poisson equation for charge densities, this study deals with the spectral distributions of turbulent energy and density fluctuations in a plasma with a strong magnetic field. Collision dominated and collisionless plasmas are considered. The nonlinear equations are solved by the use of a cascade decomposition. The dissipation necessary for a modal transfer to prevail in the direction from big eddies to smaller ones is represented by the viscosity in a collision dominated plasma. However, in a collisionless plasma, the above molecular dissipation does not exist, and its role is replaced by a collisionless dissipation, caused by the electrostatic correlations. The formula of diffusion derived here confirms the Bohm formula with a large numerical coefficient. The study emphasizes a plasma where the electron temperature far exceeds the ion temperature, and the wave length of the turbulent motion exceeds the Debye length. However, the reduced system of fundamental equations, from which the spectra are derived are analogous to that governing gravity turbulence in atmosphere and ocean with a Coriolis force. This suggests that the method and some of the results may be applicable to such problems too. Author

N68-33957*# Volt Technical Corp., Washington, D. C.
PLASMA FLOW PAST A TWO-DIMENSIONAL MAGNETIC DIPOLE

G. G. Managadze, I. M. Podgornyy, and V. D. Rusanov 6 Sep. 1968 7 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 8, no. 3, 1968 p 545–548
(Contract NAS5-12487)
(NASA-CR-98692; ST-PP-EXP-10742) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The interaction is investigated of supersonic plasma flow with a dipole magnetic field. The results of measurements are in agreement with the assumption of collisionless shock wave formation. Author

N68-33970 Texas Univ., Austin.
MICROWAVE DIAGNOSTICS OF RADIO FREQUENCY PLASMAS
Richard Perry Storm (Ph.D. Thesis) 1967 233 p
Available from Univ. Microfilms: HC $10.60/Microfilm $3.05 Order No. 67-14889

Microwave dignostics of radio frequency plasmas were carried out with a 70 GHz microwave interferometer and a 2.6–12.4 GHz radiometer of low sensitivity. The electron densities of hydrogen, helium, argon, and cesium RF-generated plasmas as well as cesium contact plasmas were measured for pressures from 1 to 330 milli Torr over a range of magnetic field strength from zero to 1800 gauss in which "anomalous" diffusion effects and the lower ion-electron hybrid resonance of electromagnetic wave propagation occurred. For the external magnetic field strength at which the lower hybrid resonance occurred at the RF oscillator frequency of 28.4 MHz, the average electron density of a hydrogen plasma was approximately 3.5×10^{11} electrons/cm^3; for this density the inequality $\omega_{p_e}^2 >> \omega_e^2$ holds so that the approximation $\omega_0 \approx (\omega_i\ \omega_e)^{1/2}$ is generally valid. Maximum electron densities observed in hydrogen, helium, and argon RF plasmas were 1.4×10^{12} electrons/cm^3, 2.8×10^{12} electrons/cm^3, and 5.0×10^{12} electrons/cm^2 respectively. Dissert. Abstr.

N68-33973 Cornell Univ., Ithaca, N. Y.
HIGHER APPROXIMATIONS IN THE THEORY OF LONGITUDINAL PLASMA OSCILLATIONS
Franco Einaudi (Ph.D. Thesis) 1967 167 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-12344

The nonlinear behavior of one-dimensional electrostatic oscillations and streaming instabilities in a homogeneous, unbounded, collisionless and fully ionized plasma is analyzed. The Vlasov–Poisson equations are solved using a singular perturbation type of analysis in which the electric field, the distribution function and the independent variable t are expanded in power series of the parameter $\epsilon = e|E_k^{(1)}|k/(m\omega_1^2)$. Differential equations have been obtained which can be solved sequentially to obtain solutions to any order in ϵ. The series expansions derived are valid for any value of t. In the case of Maxwellian background distribution function it is found that the changes in the real and imaginary part of the frequency are small, but that the free streaming terms go exponentially to zero as t becomes large with a damping rate proportional to ϵ^2. Dissert. Abstr.

N68-33992 Michigan Univ., Ann Arbor.
KINETIC EQUATION FOR A PLASMA AND ITS APPLICATION TO HIGH-FREQUENCY CONDUCTIVITY
Jerry Hui-Ming Fu (Ph.D. Thesis) 1967 102 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-15624

A kinetic equation for an inhomogeneous and non-isotropic plasma is derived in the plasma limit. The treatment is based on the joint solution of the first two members of the BBKGY hierarchy, and on a linearization procedure about the unperturbed state. The unperturbed distribution functions are unspecified. Furthermore, the unperturbed pair correlation function is eliminated in favor of the unperturbed one-particle distribution function. The resulting kinetic equation is free from Bogolyubov's adiabatic hypothesis; therefore, it is valid for arbitrary frequency. In the limiting case when the frequency under consideration is much higher than the collision frequency, a general expression for the high-frequency electric conductivity tensor is derived. Dissert. Abstr.

N68-34001 Pennsylvania State Univ., University Park.
THEORY OF NONLINEAR MIXED FREQUENCY GENERATION IN AN ANISOTROPIC PLASMA
Keith Marshall Hagenbuch (Ph.D. Thesis) 1967 74 p
Available from Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 67-15391

The Maxwell equations and the fluid equations for a plasma are expanded in a perturbation series to investigate non-linear mixed frequency generation in a gyromagnetic medium. Neutral particles and ions are assumed to be fixed, collisions are neglected, and the Debye length is assumed to be small compared with the wavelengths of propagating radio waves. Using Fourier transforms the second order amplitudes are found and the mixed frequency energy per unit area generated by two monochromatic waves in a homogeneous slab of thickness Δz during the time interval Δt are calculated. This result is applied to the case when the interacting waves are not monochromatic and when the plasma is slightly inhomogeneous. Dissert. Abstr.

N68-34042 Iowa State Univ. of Science and Technology, Ames.
EFFECTS OF THE INDUCED MAGNETIC FIELD ON THE INVISCID MAGNETOHYDRODYNAMIC CHANNEL FLOW
Khalil Ibrahim Denno (Ph.D. Thesis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-12951

The effects of a non-uniform magnetic field on a magnetohydrodynamic channel flow between two parallel plates of infinite extent are studied. The fluid flow was assumed to be electrically conducting, thermally non-conducting, inviscid and incompressible. The improvement in prevention of contact of hot conducting fluid with the channel walls was explored. This was done by including the effect of the induced magnetic field such that the magnetic Reynolds number R_m is smaller than unity but not zero. Expressions for distortions in the magnetic field and the flow field were obtained using the perturbation method. Partial differential equations resulting from the perturbation method of the induced magnetic field and distortion in the flow field are given. Solutions at the channel walls were obtained analytically using the Fourier Transforms. Dissert. Abstr.

N68-34134# Atomic Energy Commission Research Establishment, Riso (Denmark).
DRIFT WAVES IN A PARTLY IONIZED PLASMA
Flemming Oster Jan. 1968 16 p refs
(Riso-171)

A dispersion relation for the "drift" waves is obtained. Terms taking into account momentum exchange between charged particles and neutrals extend earlier results to the case of partly ionized plasmas. The dispersion relation is solved numerically for the case of a Q-machine plasma in which a neutral gas is introduced. The effects of the neutrals on the maximum growth rate and on the corresponding wavelength parallel to the magnetic field are discussed. Author (NSA)

N68-34142 Michigan Univ., Ann Arbor.
SIMULATION AND ANALYSIS OF THE LOW VOLTAGE ARC MODE IN PLASMA DIODES
Sheldon Norman Salinger (Ph.D. Thesis) 1967 391 p
Available from Univ. Microfilms: HC $17.80/Microfilm $5.00 Order No. 67-15687

The purpose of this study is to develop an understanding of the physical phenomena governing the behavior of plasma

diodes operating the low voltage are mode through the development of analytic and computer models which make use of the available experimental data. Two approaches are taken. The first one is a Monte Carlo simulation of the low voltage arc mode on a digital computer to determine the nature of the thermalization and transport phenomena in the discharge. The second approach is a reaction rate analysis to determine the relative importance of the various ionization and loss mechanisms active in the discharge. The Monte Carlo simulation is a two dimensional computer experiment in which a large random sample of the electrons and ions in the diode is tracked in a selfconsistent manner under the influence of their mutual space-charge forces and collisions with neutral atoms. A statistical analysis of the behavior of the computer model yields information relative to the behavior of the real plasma. Dissert. Abstr.

N68-34164# Princeton Univ., N. J. Plasma Physics Lab.
FLUCTUATION PROPERTIES OF STRONGLY-TURBULENT MICROWAVE-HEATED STELLARATOR PLASMAS
K. Bol and R. A. Ellis, Jr. Jun. 1968 76 p refs
(Contract AT(30-1)-1238)
(MATT-580) CFSTI: HC $3.00/MF $0.65

Resistive microwave heating was used on the Etude stellarator to obtain plasmas with the same density and temperature as the usual ohmically heated ones, but without contamination by runaway electrons or large parallel currents. Measured spatial correlation properties of the density fluctuations in these strongly turbulent plasmas conform in the main to those predicted for the most unstable electrostatic modes of a simple slab plasma. These modes are primarily electron drift waves, destabilized over a wide range of wave numbers by resonant electron interactions and to a lesser extent by resistivity. Compressional, probably hydromagnetic, vibrations of the whole plasma column are observed at the upper end of the frequency range ($\omega < 2\pi$ MHz), but remains as yet unexplained. A striking consequence of increasing the helical field is that the transport plasma by the fluctuations ultimately vanishes although the amplitude of the fluctuations in the density gradient is undiminished. Author (NSA)

N68-34199# Kernforschungsanlage, Jülich (West Germany). Inst. für Plasmaphysik.
INVESTIGATIONS ON PLASMA ACCELERATION BY ELECTROMAGNETIC SURGES FOR THE DEVELOPMENT OF PLASMA WIND TUNNELS AND PROPULSION DEVICES [UNTERSUCHUNGEN ZUR BESCHLEUNIGUNG VON PLASMA MIT ELEKTROMAGNETISCHEN WANDERWELLEN FUR DIE ENTWICKLUNG VON PLASMA-WIND KANALEN UND -ANTRIEBEN]
W. Bieger, H. Gresser, F. Hoenen, R. Läuter, F. Richter et al Jun. 1968 25 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMwF-FBW-68-38) CFSTI: HC $3.00/MF $0.65

With regard to the application to plasma wind-tunnels or propulsion devices, the generation and acceleration of plasma by an electromagnetic wave travelling along a transmission line are investigated. The first aim was to obtain information on the interaction of the wave with the plasma and to determine the initial parameters for effective operation. In the first experiments, where the efficiency of energy transfer was not a primary concern, plasma pulses with velocities between 50 km/sec and 1200 km/sec could be produced. For the production of continuously streaming beams it appears necessary to go over to a feed-back circuit. An appropriate circuit has been developed and experimentally studied. Author (ESRO)

N68-34202*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ANALYSIS OF AN ELECTROMAGNETICALLY DRIVEN CONFINED VORTEX WITH HIGH POSITIVE RADIAL REYNOLDS NUMBERS
Roger B. Stewart [1967] 13 p refs Presented at the AIAA Joint Elec. Propulsion and Plasmadyn. Conf., Colorado Springs, 11-13 Sep. 1967
(NASA-TM-X-60512) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The flow behavior in an electromagnetically driven viscous vortex is investigated for a concentric, cylindrical electrode geometry with outward radial mass flow through the chamber. The closed-form solutions obtained by Kessey and also Lewellen for the velocity, pressure, and induced magnetic field distributions with inward radial flow are applied to the present study with the assumption of small magnetic Reynolds numbers and negligible flow variations in the axial direction. An approximate form of the energy equation that includes a temperature dependent electrical conductivity is solved numerically for the temperature distribution across the vortex For the case of constant radial current flow, the applied voltage and input power are also calculated. The results of this study are compared with experimental measurements made with several arc-driven vortex accelerator configurations. Author

N68-34216# Brussels Univ. (Belgium).
GALACTIC PLASMA. ITS DYNAMICS
R. Pratap *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 167-174 refs (See N68-34207 21-30)

A general method of applying the kinetic equations to galactic plasma is outlined. The equations of self consistent fields have been applied to a rarefied medium and information regarding the magnetic fields, velocity fields, density distributions has been derived. In this the magnetic field has been derived for a particular model instead of feeding in the magnetic field a priori. Detailed calculations regarding further aspects will be reported elsewhere. Author (ESRO)

N68-34265*# National Bureau of Standards, Washington, D. C.
CASCADE THEORY OF PLASMA TURBULENCE
C. M. Tchen [1967] 36 p refs Presented at the Symp. on Advanced Probl. and Methods in Fluid Mech., Tandu, Poland, 18-23 Sep. 1967 Submitted for publication
(NASA Order R-127)
(NASA-CR-87759) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The Fourier analysis of the hydrodynamic and electrostatic equations has given a stochastic hierarchy of equations of correlations. This hierarchy, which is slowly convergent, is transformed into a more convergent *cascade* hierarchy, describing the mixing of a group of small eddies with a group of bigger ones which provide a gradient type of diffusive background flow. A quasilinear approximation is applied to the motion of the small eddies at the earliest closure. It determines the turbulent diffusion from the nonlinear effect of the small eddies on their background flow. The spectral equations for velocity and electrostatic fluctuations are derived and the spectral laws are obtained. In the inviscid ranges, the two power spectra follow the k^{-3} law. The spectra in the dissipative ranges, together with the mixed range (initial-diffusive range) are also derived. In the framework of hydrodynamic turbulence, the present scheme degenerates to the Heisenberg equation of spectrum, corrected for its divergence at large wave numbers. Author

N68-34367*# Stanford Univ., Calif. Inst. for Plasma Research.
LABORATORY PLASMA WAVE EXPERIMENTS
F. W. Crawford Apr. 1968 47 p refs Presented at NATO Advanced Study Inst. on Plasma Waves in Space and in the Lab., Roros, Norway, Apr. 1968
(Grants NGR-05-020-077; NGR-05-020-178)
(NASA-CR-98787; SU-IPR-238) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Small signal plasma wave propagation is normally analyzed in one of three limits. In the first, the plasma is assumed to be

cold. In the next higher approximation, thermal motions are taken into account via transport equations. In the third, the Boltzmann equation is employed. Each approach has its postulated domain of validity which can ultimately be checked only by experiment. This paper outlines briefly the various basic wave modes predicted in the three approximations, and describes a few of the significant laboratory plasma wave experiments that have tested the applicability of each model. It is concluded that the major predictions of cold plasma theory, macroscopic theory, and the full microscopic theory have all been supported by experiments on near-Maxwellian plasmas. The success of the small signal theory provides the foundation on which extensions to nonlinear plasma behavior can be built with confidence. The next phase of experimental effort should be directed to detailed verification of such nonlinear theory. Author

N68-34368# California Univ., Livermore. Lawrence Radiation Lab.
DECAY MODES OF A DENSE PLASMA IN A MAGNETIC WELL
F. H. Coensgen, W. F. Cummins, R. E. Ellis, and W. E. Nexsen, Jr. 20 Jun. 1968 18 p refs Presented at 3d Intern. Conf. on Controlled and Plasma Phys., Novosibirsk, USSR, 1–7 Aug. 1968
(Contract W-7405-ENG-48)
(UCRL-70869; CONF-680805-5) CFSTI: HC $3.00/MF $0.65

Energetic deuterium plasmas of $\beta \rightarrow 5\%$ are formed in an open-ended magnetic well system using the techniques of plasma injection and magnetic compression. Containment in the quasi-dc field following compression is studied. Under ordinary vacuum wall conditions there are rapid plasma losses, accompanied by rf signals at ion-cyclotron frequencies, ω_{ci}. This activity is tentatively identified as the ion-ion instability due to a double humped ion energy distribution. The loss has been suppressed by forming gas-free Ti surfaces throughout the chamber. Under these latter conditions, it was also shown that interchange instabilities are suppressed by the minimum-B field for densities as high as 5×10^{13} cm^{-3}. The D+ energy distribution as derived from analysis of charge-exchange fast atoms extends from 2 to 50 keV and, following the initial containment phase, remains essentially unchanged with time. Author (NSA)

N68-34372# Westinghouse Research Labs., Pittsburgh, Pa.
PLASMA PRODUCTION BY A HIGH POWER Q SWITCHED LASER Quarterly Progress Report, 1 Feb.–30 Apr. 1968
A. G. Engelhardt 1 May 1968 5 p
(Contract AT(30-1)-3472)
(WERL-3472-10; QPR-1) CFSTI: HC $3.00/MF $0.65

During this period measurements were made of electron temperature and density in aluminum plasmas using Thomson scattering. The targets struck by the focused Q-switched laser beam were 75-μ-radius aluminum spheres. The retracting pedestal apparatus continues to operate reliably. The theoretical work has been partly concerned with the development and application of the nonlinear theory to experimental results and partly concerned with the thermokinetic or linear theory. Author (NSA)

N68-34375# California Univ., Livermore. Lawrence Radiation Lab.
STABILITY OF E LAYER AND PLASMA IN ASTRON CONFIGURATIONS
G. Benford, D. L. Book, N. C. Christofilos, T. K. Fowler, V. K. Neil et al 21 Jun. 1968 16 p refs Presented at 3d Intern. Conf. on Controlled and Plasma Phys., Novosibirsk, USSR, 1–7 Aug. 1968
(Contract W-7405-ENG-48)
(UCRL-70878; CONF-680805-4) CFSTI: HC $3.00/MF $0.65

Reverse-field equilibria, stability of the layer, stability of the plasma, and the layer–plasma coupling are discussed. The result is an example configuration of a plasma of appreciable beta imbedded in an E layer, with many features favorable toward stability. NSA

N68-34377# California Univ., Livermore. Lawrence Radiation Lab.
IGNITION OF A PLASMA UNDERGOING BOHM DIFFUSION
N. C. Christofilos 27 May 1968 11 p ref
(Contract W-7405-ENG-48)
(UCID-15334) CFSTI: HC $3.00/MF $0.65

Plasma parameters are found where the toroidal plasma can be sustained by the fusion reaction products while the diffusion rate is 15 to 30 times slower than the Bohm rate. A closed confinement geometry is proposed in the form of a polygon where long straight sections are connected with short toroidal sections. NSA

N68-34397# Illinois Univ., Urbana. Coordinated Science Lab.
THE INFLUENCE OF GAS COMPOSITION AND OF SIGNAL WAVEFORM ON PROPERTIES OF THE PLASMA DISPLAY
Brij Mohan Arora May 1968 125 p refs
(Contract DAAB07-67-C-0199)
(R-377; AD-672517)

The Plasma Display is a new digital storage device. The development of the Display was motivated by the anticipated needs of the PLATO, a computer controlled teaching system at the laboratory. The PLATO system utilizes a high speed digital computer as a control element for teaching a number of students simultaneously. In the experimental system at the laboratory, each student is provided with an electronic key set as a means of communication with the central computer (CDC 1604) and a television screen for presenting him the information selected by the computer. In theory, a large number of student terminals, located at various places, may be connected to a central computing facility and many different courses may be taught simultaneously. However, the high cost of TV storage tubes for every terminal and the video transmission lines necessary for such a system prohibits its practice outside the research laboratory. Author (TAB)

N68-34402# California Univ., Livermore. Lawrence Radiation Lab.
CRITERIA FOR STABILIZATION OF ELECTROSTATIC MODES IN MIRROR CONFINED PLASMAS
H. L. Berk, T. K. Fowler, L. D. Pearlstein, R. F. Post, J. D. Callen (Inst. of Advanced Res., Princeton, N. J.), et al 25 Jun. 1968 18 p refs Presented at 3d Intern. Conf. on Controlled and Plasma Phys., Novosibirsk, USSR
(Contract W-7405-ENG-48)
(UCRL-70866; CONF-680805-3) CFSTI: HC $3.00/MF $0.65

Stabilization criteria for magnetic mirror-confined plasmas were investigated. The authors have (1) recalculated the critical lengths to include refinements in the analysis of wave-reflection processes, (2) taken into account the stabilizing effects of longitudinal magnetic field and density gradients on the resonant absolute modes, and (3) considered modifications of the collisional loss-cone distributions, primarily as a way of reducing the critical radius. The overall result of the various calculations is to yield more reliable stability criteria, and ones which permit a greater flexibility in the choice of parameters. NSA

N68-34409# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
SINGULAR-PERTURBATION METHODS APPLIED TO MAGNETOGASDYNAMICS AND PLASMA PROBLEMS Final Report, 1 Jun. 1965–31 May 1968

I-Dee Chang 31 May 1968 8 p
(Grant DA-ARO(D)-31-124-G649)
(AROD-4284-8-E; AD-672516)

The research activities fall in two categories: (a) The effect of a magnetic field on the hydrodynamic turbulence in ionized gas, (b) motion of particle suspensions in viscous fluids. Author (TAB)

N68-34472# California Univ., Livermore. Lawrence Radiation Lab.
MIRROR CONFINEMENT AND ITS OPTIMIZATION
R. F. Post 20 May 1968 39 p refs Presented at the Intern. Conf. on Plasma Confined in Open-ended Geometry, Gatlinburg, Tenn., 1–4 Nov. 1967
(Contract W-7405-ENG-48)
(UCRL-70681; CONF-671127-4) CFSTI: HC $3.00/MF $0.65

The further optimization of mirror confinement mainly hinges on satisfying two requirements: (1) adequate suppression of high-frequency wave–particle instabilities; and (2) minimization of enhanced end losses associated with the ambipolar potential. There is reason to believe that satisfactory solutions to both of these requirements can be found, by taking advantage of the topology and flexibility of open-ended systems. In such systems the basic problem is one of controlling the low-energy end of the ion energy spectrum, since both wave–particle instabilities and ambipolar ion losses are traceable to this class of particles. In this paper, the stabilizing effects of modifying ion distribution functions by the addition of "warm" plasma components are considered. The modes considered are (1) the high-frequency loss-cone convective mode and (2) the loss-cone drift cyclotron mode. It is shown that in high-mirror-ratio systems these two important modes should be strongly stabilized by the addition of a few percent of Maxwellian warm plasma ions with mean energies small compared to those of the contained ions. Some of the practical problems of creating such a situation are discussed. Author (NSA)

N68-34518*# Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics.
DIAGNOSTICS OF ACCELERATING PLASMA Semiannual Progress Report, 1 Sep. 1967–29 Feb. 1968
T. N. Lie, K. F. Lee, and C. C. Chang 1 Mar. 1968 44 p refs
(Grant NGR-09-005-025)
(NASA-CR-96774; Rept.-68-005; SAPR-4) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The current sheet velocities in two groups of coaxial plasma accelerators, one using refractory and the other non-refractory materials as insulators, are compared. A large difference in sheet velocity exists between the two groups in all cases, i.e., the velocities in the accelerators with non-refractory insulators are slower. This is caused by the marked difference between the two groups of accelerators in the radial current carried by the current sheet. The impurity mass flow which follows the current sheet is observed particularly with the non-refractory insulator. The results obtained here generally support the physical model on insulator ablation. The accelerators with refractory insulators and with clean systems also have a similar process and the sheet velocity is limited. In this case, however, degassing of light gas, e.g. hydrogen from the insulator wall, is probably responsible for the drag rather than ablation. The ablation problem is analyzed, mainly following Workman's results with the inclusion of an additional dimensionless parameter. Analysis and measurements show reasonable agreement over a wide area of accelerator operation. Author

N68-34524# ARO, Inc., Arnold Air Force Station, Tenn.
ELECTRICAL CONDUCTIVITY OF A SEEDED NITROGEN PLASMA Final Report
G. W. Garrison Arnold Eng. Develop. Center Jul. 1968 43 p refs Submitted for Publication
(Contract F40600-69-C-0001)
(AEDC-TR-68-116; AD-672249)

The electrical conductivity of a nitrogen plasma seeded with potassium (in the form of powdered K_2CO_3) was measured experimentally under conditions similar to those present in MHD accelerators and compared with existing theory. By accounting for the nonuniform temperature profile in the flow, reasonable agreement between theory and experiment was found. The nitrogen vibrational mode was equilibrated at the gas temperature, and the degree of electron thermal nonequilibrium was found to be small with an energy loss factor of between 50 and 100 indicated for the electron-nitrogen interaction. The free potassium in the gas was determined to be 50 percent or less of the amount expected based on complete vaporization of the K_2CO_3 added to the gas. This was attributed to incomplete vaporization of the seed and seed condensation on the apparatus walls. Author (TAB)

N68-34616# Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research.
OBLIQUE HYDROMAGNETIC SHOCK WAVES
A. E. Robson and J. Sheffield Jun. 1968 14 p refs Presented at the 3rd IAEA Conf. on Plasma Phys. and Controlled Nucl. Fusion Res., Novosibirsk, USSR, 1–7 Aug. 1968
(CN-24/A-6; ORO-3647-3; CONF-680805-6) CFSTI: HC $3.00/MF $0.65

An experiment is described in which shock waves are propagated in a magnetized hydrogen plasma with Alfvén Mach numbers up to $M_A = 5$ and at angles to the magnetic field, α from 90° to 40°. The plasma, of density $\approx 5 \times 10^{14}$ cm^{-3} and temperature ≈ 1 eV is created in a pyrex chamber 45 cm diameter and 93 cm long by means of an oscillatory z discharge. The initial magnetic field is 500 to 1000 G. A curved magnetic piston is driven into the plasma by exciting a rapidly rising θ current in a single-turn loop of short axial length arranged round the tube on its midplane. A curved shock front propagates ahead of the piston in the manner of a bow wave. Magnetic and electric probes are used to study the development and structure of the shock front. The results are compared with numerical computations of shock structure using hydromagnetic equations. Author (NSA)

N68-34660# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
TECHNIQUES FOR REDUCING EXPERIMENTAL LANGMUIR PROBE DATA TO OBTAIN A COMPARISON WITH CURRENT THEORIES
E. L. Battle and R. B. Bell 1967 14 p refs
(AFIT-TR-68-7; AD-672318)

A technique is given for reducing experimental Langmuir probe traces using the exact theory developed by Laframboise. The method yields charged particle number density and plasma potential taking full account of sheath effects, without the requirement for trial and error iteration. All necessary curves are given and the technique is applied to the reduction of experimental data taken in a DC glow discharge in argon in order to illustrate the method. Author (TAB)

N68-34678# Purdue Univ., Lafayette, Ind. Project Squid Headquarters.
ELECTRON ENERGIES IN ELECTRICAL DISCHARGES EXCITED AT MICROWAVE FREQUENCIES
J. L. Franklin and Stanley A. Studniarz Jun. 1968 26 p refs
(Contract N000 14-67-A-0226)
(SQUID-TR-RICE-4-PU; AD-672223)

The electron energy distribution in plasmas excited at microwave frequencies were measured by the retarding potential grid technique. The electron energy distribution and the mean electron energy in discharges of fourteen different gases are given. The electron energy range was normally 10-20 eV. Abnormally high mean electron energies (< 40 eV) and densities were observed in plasmas of SO_2 and H_2S. The electron energy distribution fitted in

all cases the Maxwellian energy distribution, except for discharges of SO2 and H2S which fitted approximately the form of Druyvestyn distribution. An explanation, based on the effect of negative ions on the ambipolar diffusion coefficient for the abnormalities observed in SO2 and H2S plasmas is proposed. Author (TAB)

N68-34721# Aerospace Corp., El Segundo, Calif. Lab. Operations.
ANALYTICAL SOLUTION OF THE ENERGY BALANCE EQUATION FOR THERMAL INDUCTION PLASMAS IN ARGON, SEPTEMBER 1967–MARCH 1968
Hans U. Eckert Apr. 1968 15 p refs
(Contract F04695-67-C-0158)
(TR-0158(3220-50)-2; SAMSO-TR-68-243; AD-672247)

The Heller-Elenbaas equation for electric arcs is applied to the case of a thermal induction plasma in argon at atmospheric pressure. The dissipated electrical energy is considered to be predominantly lost by conduction to the side walls. For obtaining a solution in closed form, the variation of the induced electric field with radial distance is assumed to follow a power law and use is made of the experimental finding that for argon at moderate temperatures the electric conductivity increases approximately in proportion with the Schmitz heat conduction potential. These two steps permit solving the equation by a Bessel function where a transformed radial coordinate accounts for the field nonuniformity. The solution yields the relative distributions of conduction potential and electric conductivity and shows that with decreasing skin depth these distributions tend toward a rectangular shape. The condition that the profiles vanish at the tube wall establishes an eigenvalue for the induced electric field at this position. From this expression, in combination with the induction law and Poyntings theorem, a relationship between the skin depth and the applied rf magnetic field is obtained which permits determination of the values of conductivity and temperature at the tube axis and thus also their absolute distributions from external conditions. These conditions can be collectively expressed by the time rate of change of applied magnetic flux which emerges as the significant independent parameter. The argon plasma could not be maintained below a flux change of 25 V and dissipates energy most efficiently at about 32 V. Author (TAB)

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N68-33619 Colorado State Univ., Fort Collins.
THEORY OF ABSORPTION COEFFICIENTS IN THIN SEMICONDUCTOR FILMS
Neal David Wilsey (Ph.D. Thesis) 1967 70 p
Available from Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 67-13215

The theory of optical absorption coefficients for direct interband transitions in semiconductors is extended to include thin films. The absorption coefficients which are obtained for thin films are compared with those calculated for bulk materials. It is found that the absorption coefficients for transitions near the band edge can be represented by a series of step functions. This result reduces to the bulk material result when the crystal thickness is large. The model is applied to the Kronig–Penney model and it is shown that measurements of optical absorption in thin films can give information about the band structure of semiconductors. Boundary conditions are found to affect the optical absorption edge. Consequently, the details of the absorption curves yield information about the boundary conditions for sufficiently thin films. Dissert. Abstr.

N68-33627*# Oak Ridge National Lab., Tenn. Thermonuclear Div.
MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION Quarterly Report, 1 Jan.–31 Mar. 1968
W. F. Gauster, K. R. Efferson, J. B. Hendricks, D. M. Kroeger, M. S. Lubell et al 17 May 1968 47 p refs
(NASA Order H-29278A; Contract W-7405-ENG-26)
(NASA-CR-96610; ORNL-TM-2233; QR-4) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The observations on the flux flow and stability performance of bare NbTi strips have been extended to include two additional compositions, viz Nb–5% Ti and Nb–10% Ti, which have similar critical temperatures but widely different upper critical fields and normal state resistivities. The results obtained with these samples confirm our previous conclusion that heat transfer phenomena rather than electrical effects (or a fortuitous interaction between electrical and heat transfer) were of primary importance in understanding premature take-offs. These results agree well with the observation on temperature fluctuations as described below. It has also been shown that the analysis of the field dependent recovery power can yield the heat flux as a function of temperature for the film boiling regime. To improve the analysis on compound conductors, it is necessary to make direct measurements of the magnetoresistance of the stabilizer and of the critical temperature of the superconductor. Author (NSA)

N68-33705 Rutgers Univ., New Brunswick, N. J.
THERMODYNAMIC AND RESISTIVITY EFFECTS IN THE COMPRESSION OF SOLIDS
Edward Joseph Hanus (Ph.D. Thesis) 1967 137 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-14715

Changes in the temperature of powdered solids following compression were determined. Tablets were prepared from materials of known heat capacity at varying speeds and pressure and were collected into thermally insulated vessels containing a suitable liquid. The resulting increase in temperature of the liquid was measured after equilibrium was established, and it was observed that the increases in temperature were directly related to the speed of the tablet machine and to compression pressure. Tablet temperatures at time of compression were predicted by an extrapolation of the data. Thermal energy was converted to its mechanical equivalent thus providing a means for estimating the energy expended in the process of compressing tablets. Color changes observed following the use of thermochromic indicators in tablets qualitatively supported the validity of the conclusions. Quantitative confirmation was obtained by directly heating samples of tablets. Dissert. Abstr.

N68-33714 Michigan Univ., Ann Arbor.
THE INTERACTION OF FERROELECTRIC POLARIZATION FIELDS WITH SEMICONDUCTOR FILMS
Paltiel Buchman (Ph.D. Thesis) 1967 154 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-15599

The purpose of this investigation is: (1) to study the effect of polarization reversal of $BaTiO_3$ on the conductivity and mobility of germanium and tellurium films deposited on ferroelectric substrates, (2) to investigate the effect of ambient atmospheres on the transport properties of carriers in the semiconductor films, and (3) to utilize the semiconductor films to study certain properties of the $BaTiO_3$ surface such as the surface space charge layer and surface strains at crystallographic phase transitions. The results of the first objective show that the resistance of the semiconductor changes by a large factor with polarization reversal (i.e., $\cong$ 10). For the second objective the effect of oxidation of germanium and

tellurium can be summarized: The oxidation rate of the germanium film at room temperature follows a parabolic time dependence suggesting a diffusion process. With respect to the third objective it is demonstrated that the semiconductor film can be used to study the surface properties of $BaTiO_3$. Dissert. Abstr.

N68-33743 Northwestern Univ., Evanston, Ill.
MAGNETORESISTANCE OSCILLATIONS IN ANTIMONY DOPED GRAY TIN
Bruce Lee Booth (Ph.D. Thesis) 1967 231 p
Available from Univ. Microfilms: HC $10.60/Microfilm $3.00 Order No. 67-15192

Magnetoresistance oscillations were measured in Sb-doped gray tin utilizing the highly sensitive field modulation technique. Accurate determinations were made of the oscillatory periods and effective masses of the $\Gamma_8^-(k = 0)$ conduction band electrons in the principal directions for impurity concentrations which varied by a factor of over one thousand from 8×10^{15} to 1×10^{19} atoms per cm^3. The angular variation of the period was fitted to a mathematical model (similar to that proposed by Dresselhaus et al.), for the Γ_8^- valence bands of germanium. The resulting Fermi surface model shows <111> protrusions on an otherwise spherical Fermi surface. These protrusions gave an observed 5% increase in the <111> cross sectional area relative to the <100> area. The degree of nonsphericity as measured by a nonsphericity parameter F was found to be independent of impurity concentration and it agreed closely with the parameter evaluated for the Γ_8^+ bands of germanium. Dissert. Abstr.

N68-33815 Michigan Univ., Ann Arbor.
THE EFFECT OF MECHANICAL STRESS UPON RECTIFYING METAL-SEMICONDUCTOR CONTACTS
Robert Morris Anderson, Jr. (Ph.D. Thesis) 1967 138 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-15585

The purpose of this study is to investigate the effects of mechanical stress on the electrical properties of metal-silicon rectifying contacts. Conditions are presented which allow a prediction of the volt-ampere characteristic of a general metal-semiconductor contact. The stress dependence of the various quantities appearing in the above current expressions is discussed theoretically and a linear decrease in the band gap with compressive strain is developed. This extrapolation yields a prediction of the strain dependence of the electronic barrier height as a function of the type and direction of the stress, as well as the crystallographic orientation of the crystal. The other major mechanism is described as a stress dependent shift in the energy levels of trapping centers in the space charge region. It appears that the trap levels move toward the intrinsic level when compressional stress is applied. This has the effect of increasing the space charge generation-recombination current. Experimental data are presented on small area, evaporated gold contacts on n-type silicon. Dissert. Abstr.

N68-33861 Rice Univ., Houston, Tex.
A MECHANICAL MEASUREMENT OF THE ENERGY DISSIPATION ASSOCIATED WITH THE MOTION OF MAGNETIC FLUX THROUGH SUPER-CONDUCTING INDIUM STRIPS AND FILMS
David Robert Smith, Jr. (Ph.D. Thesis) 1967 96 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-13123

A torsion pendulum was used to measure the energy dissipation occurring in strips and in vacuum-deposited films of indium as a function of the velocity with which they moved through a magnetic field. Measurements were made both above and below the superconducting transition temperature T_c. No dissipation was observed either above or below T_c when the strips moved through a uniform magnetic field applied in a direction perpendicular to the motion. Energy losses were observed above T_c when the strips moved through small localized, inhomogeneous magnetic fields. These losses, presumably due to eddy currents, were not observed with the films because of their small volumes. Below T_c energy dissipation occurred in both the strips and the films when they moved through the localized fields. The energy loss below T_c contains a part proportional to the velocity with which the indium samples pass through the fields and a velocity independent part. Dissert. Abstr.

N68-33883 Rutgers Univ., University Park, N. J.
MODEL POTENTIALS IN LATTICE DYNAMICS
John Stewart Brown (Ph.D. Thesis) 1967 98 p
Available from Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-14698

Calculations are presented of a number of lattice dynamical properties of the ideal inert gas solids using model potentials to represent the effective interaction of the atoms in these substances. In the inert gas solids, lattice parameters are calculated for both the Lennard-Jones (m-6) potential and the Buckingham Exp-6 potential, using a number of approximations in the perturbation expansion of the lattice free energy and its first and second volume derivatives at 0°K. The resulting sets of parameters are used to study a number of lattice properties. In addition the infrared absorption spectrum of solid Ar is discussed and a comparison given with earlier calculations. The Lennard-Jones potential parameters are used to discuss isotopic differences in volume and sublimation energy of solid Ne and Ar isotopes. It is shown that the present calculations are in good accord for the volume difference in solid Ne. Dissert. Abstr.

N68-33971 New Mexico Univ., Albuquerque.
THE EFFECT OF NUCLEAR RADIATION ON OXIDIZED SILICON SURFACES
Jerry Aundos Hood (Ph.D. Thesis) 1967 127 p
Available from Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-11760

The surface controlled devices studied were the metal oxide-silicon capacitor and the insulated gate field effect transistor. For both devices, the surface is a thin metal film deposited on an oxidized silicon crystal. Both devices operate by inducing a particular charge distribution at the silicon surface with a bias voltage between the metal film and the silicon crystal. It is this voltage-charge relation which changes with irradiation. With the use of silicon alloy diodes, the radiation-induced defects in the silicon crystal are shown to have negligible effect on the surface controlled devices, at radiation levels where a significant change in characteristics is observed. The radiation damage of interest is, therefore, in the oxide and/or the oxide-silicon interface. Dissert. Abstr.

N68-34077*# General Precision Systems, Inc., Little Falls, N. J. Aerospace Research Center.
BEAM ALIGNMENT TECHNIQUES BASED ON THE CURRENT ENHANCEMENT EFFECT IN PHOTOCONDUCTORS Final Technical Report, 15 Oct. 1967–15 Jun. 1968
Cecil B. Ellis 31 Aug. 1968 134 p
(Contract NAS12-8)
(NASA-CR-86093; RC-68-8) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The photoconductive enhancement effect is an increase in photocurrent when two illuminated spots are brought into coincidence on opposite sides of a thin photoconductor having translucent electrodes. Initially discovered in one type of polycrystalline CdS cell, the effect has now been found with three other types of CdS cell designs, including a single crystal of CdS pressed between conducting glass electrodes. An analogous

photovoltaic enhancement effect has also been found in two kinds of CdS cells, which has a frequency response bandwidth for modulated light of at least 5000 cps. In addition, a reverse effect is found in single crystal Ge cells, where collinearity of the opposing beams causes a decrease in the photocurrent. Many static and dynamic features of the behavior of all of these cells have now been measured. Author

N68-34154# Atomic Energy Commission Research Establishment, Riso (Denmark).
INVESTIGATION OF MAGNONS IN RARE EARTH METALS BY INELASTIC NEUTRON SCATTERING
H. Rjerrum Moller Mar. 1968 70 p refs
(Riso-178)

A description is given of an experimental investigation of the magnetic interactions in Tb and Tb–10% Ho by the technique of inelastic neutron scattering. The experimental method is described with special regard to those features of the technique that allow an accurate determination of the energies and lifetimes of the magnons. The interpretation of the data is discussed, with reference to the relation between the conduction electron band structure and the indirect exchange interaction between the magnetic ions. The interactions of magnons with each other and with phonons, electrons, and impurities are also considered. NSA

N68-34165*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
MAGNETIC PROPERTIES OF SELECTED SPACECRAFT MATERIALS
P. W. Droll and E. J. Iufer [1967] 9 p refs
(NASA-TM-X-60414) CFSTI: HC$3.00/MF$0.65 CSCL 20C

This paper summarizes the results of an investigation of the magnetic properties of selected spacecraft materials. Experimental measurements describing the effects of magnetic field exposure, shock, vibration, and temperature on the induced and remanent dipole moment of Kovar, Dumet, Invar, Nickel, 304SS, 410SS, and 416SS rod specimens are presented. Analysis of the data indicates that temperatures of 77°K to 390°K, shock, to 50 g, and vibration to 25 g produce negligible effects on dipole moment for specimens having length-to-diameter ratios of 5.5. The remanent and induced moments of rod samples having length-to-diameter ratios of 40 or less are linearly related to magnetizing forces less than 25 oersteds. By means of the data provided, predictions of the dipole moment can be made for these materials if the alloy, demagnetization factor, magnetizing field, volume, and length-to-diameter ratio are known. Author

N68-34181# Imperial Coll. of Science and Technology, London (England). Dept. of Physics.
SOLID STATE PHYSICS IN PARTICULAR METALS
B. R. Coles 14 Feb. 1967 16 p
CFSTI: HC$3.00/MF$0.65

Superconductivity in alloys are associated with the features of the electronic configuration of the metals and the position of the metals in the periodic table of elements. ESRO

N68-34316# California Inst. of Tech., Pasadena.
MOLECULAR IONIZATION IN DENSE MEDIA Final Technical Report
G. Wilse Robinson 17 Jun. 1968 11 p refs
(Contract AT(04-3)-383)
(CALT-383-5) CFSTI: HC$3.00/MF$0.65

Excitation transfer in organic crystals was studied. A theory of electronic energy relaxation in the solid phase was considered. Results indicated that in π-electron organic crystals the degree of triplet excitation migration is much greater than that for the singlet and that the interaction matrix element associated with the triplet may be of the same order as that for the lowest singlet. An empirical method by which the Franck–Condon factors may be ascertained from the electronic energy gaps in π-electron molecules was considered, and the results were used to estimate radiationless transition probabilities for a number of systems. Triplet–triplet annihilation in pure and mixed organic crystals was studied. The role of triplets in photosynthesis is considered. Spectra of excited molecules were observed. A general mechanism by which both symmetry-forbidden and multiplicity-forbidden transitions of a molecule in a perturbing environment could gain intensity is presented. NSA

N68-34373# Weather Bureau, Washington, D. C.
MANUAL OF SURFACE OBSERVATIONS (WBAN). CIRCULAR N
Jul. 1968 66 p *Its* Change No. 15 Revised
(NAVAIR-50-1D-505; AD-672366) GPO: $0.40

This manual was prepared by Weather Bureau personnel, with the collaboration of representatives of the Air Force and Navy, to secure uniformity in taking and recording surface observations. It has been approved by appropriate officials of the Weather Bureau, Air Force, and Navy for joint use, as indicated by the abbreviation WBAN appearing in the title. Therefore, the instructions are equally directive upon all meteorological personnel of these three organizations. TAB

N68-34462# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science.
ACCOMMODATION OF LATTICE MISMATCH AT HETEROJUNCTIONS
R. S. Mroczkowski, A. F. Witt, and H. C. Gatos Jul. 1968 18 p refs
(Contract Nonr-3963(05))
(TR-12; AD-672555)

The accommodation of lattice mismatch at heterojunctions grown by back-melting and subsequent regrowth was investigated employing the InSb-GaSb system. Single crystals of either GaSb or InSb served as the one component (substrate) of the heterojunctions and the regrown part was an alloy of the general formula GaxIn1-xSb. The lattice mismatch at the heterojunction was varied by varying the composition of the regrown alloy. It was found that the accommodation of the lattice mismatch takes place by the generation of dislocations the number of which is consistent with a simple linear lattice model. Author (TAB)

N68-34477# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Angewandte Kernphysik.
MEASUREMENTS OF ISOBARIC ANALOGUE STATES IN Cr-52 AND Ni-60 BY THE HIGH RESOLUTION NEUTRON TIME-OF-FLIGHT METHOD AND BY THE (p,γ) REACTION
E. Arai and H. Miessner Dec. 1967 15 p refs
(KFK-704)

The neutron time-of-flight method was used to investigate the cross sections of the reactions ^{59}Co(p,n)^{59}Ni and ^{51}V(p,n)^{51}Cr. The cross sections show a fine structure superimposed on a gross structure; the peaks of the latter are interpreted as analogue states of ^{60}Co and ^{52}V in the compound nuclei ^{60}Ni and ^{52}Cr, respectively. Additional (p,γ) cross-section measurements on ^{59}Co and ^{51}V served as a check and were also used to determine the Coulomb displacement energy. Author (NSA)

N68-34478*# GCA Technology Div., GCA Corp., Bedford, Mass.
PHOTOELECTRIC YIELDS OF METALS IN THE VACUUM ULTRAVIOLET Final Report
J. A. R. Samson and R. B. Cairns Nov. 1966 60 p refs
(Contract NAS5-3918)
(NASA-CR-96720; GCA-TR-66-17-N) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The object of this study was to measure the absolute photoelectric yield of various cathodes, including W, Ni, Al, Pt, LiF, and SrF_2 from 250 to 1300 Å. Also, the reproducibility of these yields were to be investigated periodically and conclusions to be drawn about their stability. The effects of irradiation by 1 MeV electrons on the yield of LiF was investigated. The photoelectric yields of three compounds, namely, CuBe, SrF_2, and LiF are tabulated in this report. The conditions under which enhanced yields can be obtained and the stability of the yields are discussed. Author

N68-34483# Argonne National Lab., Ill.
MECHANISM OF SPUTTERING OF SOLIDS [O MEKHANISME RASPYLENIYA TVERDYKH TEL]
B. M. Gurmin, T. P. Martynenko, and Yu. A. Ryzhov Jun. 1968 6 p refs Transl. into ENGLISH from Fiz. Tverd. Tela (Leningrad), v. 10, 1968 p 411–414
(ANL-TRANS-627) CFSTI: HC$3.00/MF$0.65

The sputtering of polycrystalline Zr, W, Mo, ZrC, and a W–Mo alloy by normal 5-, 11-, and 17-keV incident Ar+ ions has been investigated. A comparison of the experimental values of sputtering coefficients of pure Zr and ZrC as well as of W, Mo, and W–Mo alloys shows that the part played by focusons in the sputtering is insignificant even at such ion energies that the penetration depth of ions is of a sufficient magnitude. Author (NSA)

N68-34500# Marquette Univ., Milwaukee, Wis.
RESEARCH ON DEFECT CONTROLLED ELECTRICAL PROPERTIES OF RUTILE
W. M. Hirthe Washington Office of Aerospace Research Apr. 1968 58 p refs
(Contract AF 33(615)-1244)
(ARL-68-0065; AD-672281)

The electrical conductivity of single crystals of rutile (TiO2) was measured in the c and a directions over a temperature range 1000 degrees -1500 degrees C and from 1 to 10 the the -15th power atm of oxygen. The non-stoichiometric defect structure was rationalized on the basis of quasi-free electrons, both triply and quadruply ionized titanium interstitials, and acceptor impurities. A model based on the electrode blocking of titanium interstitials is proposed to explain the electrical transients observed below 1000 degrees C. An electron mobility of about 0.1 cm sq/volt-sec has been calculated by combining thermogravimetric and conductivity data above 1100 degrees C. A calculation of the cohesive energy of TiO2 using the Born-Mayer model indicates that the bonding in rutile is predominantly ionic. Author (TAB)

N68-34502# Sperry Rand Research Center, Sudbury, Mass.
INVESTIGATION OF BRILLOUIN SCATTERING PHENOMENA AND APPLICATION Final Report, 15 Jun. 1967–14 Jun. 1968
Donald H. McMahon Jul. 1968 70 p refs
(Contract N00014-67-C-0534)
(SRRC-CR-68-32; AD-672358)

During the initial six months of the contract we: (1) measured the longitudinal and shear wave attenuation of sound propagating along the c axis in crystals of LiNbO3 and LiTaO3; (2) observed acoustic second harmonic generation in LiNbO3 for both shear and longitudinal waves propagating along the c axis; (3) developed the theory of second harmonic generation to the point where the technique can be used to determine values of the third order elastic constants; (4) measured the necessary elasto-optic coefficients in LiNbO3 (P sub 13 and P sub 24); and (5) used the theory of second harmonic generation and the observed data to calculate experimental values for the third order elastic constants C sub 333 and C sub 444. During the final six months of the contract we: (1) developed the theory of acoustic second harmonic generation in piezoelectric crystals; (2) developed the mathematical analysis for determining the relative efficiency of optical Bragg diffraction as a function of interaction geometry; (3) developed the wetted mercury contract for increasing the intensity of acoustic waves; and (4) measured the acoustic attenuation of a axis longitudinal and shear waves in LiNbO3. Author (TAB)

N68-34550 Indiana Univ., Bloomington.
THE GENERAL GRIFFITHS INEQUALITIES ON CORRELATIONS IN ISING FERROMAGNETS
Douglas Gilbert Kelly (Ph.D. Thesis) 1967 77 p
Available from Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-15115

A general Ising ferromagnet system is mathematically defined, and proof is offered of the generalized Griffiths results. Examples are given disproving certain conjectured extensions, and the (unsolved) converse problem of determining sufficient conditions for $J_A \geq 0$ (ferromagnetism) is examined in terms of the moments $\langle \sigma R \rangle$. Two other related approaches to the problem are discussed, and two methods are unified with an abstract statement of the problem involving the L^1 algebra of the group of subsets of N under symmetric difference. This approach leads to a characterization of ferromagnetism in terms of the probabilities of the spin configurations. The question of concavity of magnetization is examined briefly. Dissert. Abstr.

N68-34560# Wayne State Univ., Detroit, Mich.
OPTICAL STUDIES OF F-AGGREGATE COLOR CENTERS IN IRRADIATED LITHIUM FLUORIDE
Karel L. Vander Lugt (Ph.D. Thesis) 1967 81 p refs
(Contract AT(11-1)-1054)
(COO-1054-40) CFSTI: HC$3.00/MF$0.65

F centers and certain F-aggregate centers were produced in pure LiF by exposure to γ rays, x rays, or neutrons at room temperature. The crystals were subjected to selective bleaching techniques, and optical absorption, luminescence, and photoconductivity measurements were made. R_1 and R_2 bleach near 300°K revealed the existence of a new color center whose main absorption band covers the region of the R_1 and R_2 bands. The new center is not related to any of the known color centers, and facilitates the conversion of F^+_3 centers into R centers according to the mechanism $F^+_3 + e \rightarrow R$, where the electron is provided by the photoionization of the new color center by the R bleach. The destruction of R centers in LiF by R_1 and R_2 bleach was found to occur by two concurrent mechanisms: (a) decomposition of an R center into an M center and an F center, and (b) conversion of an R center into another color center whose absorption band (550 mμ) is in the N-band region. NSA

N68-34561# Hewlett-Packard Co., Palo Alto, Calif.
INVESTIGATION OF SEMICONDUCTOR SCHOTTKY BARRIERS FOR OPTICAL DETECTION AND CATHODIC EMISSION
Robert J. Archer, Jerome Cohen, and Juri Vilms Jun. 1968 66 p refs
(Contract F19628-68-C-0090)
(AFCRL-68-0302; SR-2; AD-672287)

The photoemissive quantum yield from Au-Si contacts is larger by at least a factor of 2 near the perimeter of the vacuum-evaporated Au pad than in its central region. This property promises the possibility of increased yield through control of the Au deposition process since it is unique to the initial Au-evaporated edge region and is not found for the perimeters of pads which are etched to decrease their size. Calculations of the properties of the optical impedance matching structure for Au-Ge contacts predict yield enhancements of up to 30-fold at 5 micrometers, and demonstrate that the spectral band width of enhanced yield can be adjusted by varying the thickness of the thin Au film. Processing

procedures for Au-p-type-Si contacts are established. Infrared photoemission measuring equipment and associated cryostat apparatus are complete. A Ag-ZnSe vehicle has been developed for cathodic emission studies. Cathodic emission vacuum apparatus and measuring techniques are described and the results for emission from Ca-coated Ag-GaP contacts are reported and interpreted in terms of a simple model for the process. Author (TAB)

N68-34569# Connecticut Univ., Storrs.
LOW TEMPERATURE PHYSICS RESEARCH Final Report, 16 Jun. 1959–15 Jun. 1968
Charles A. Reynolds 15 Jun. 1968 25 p refs
(Contract Nonr-2967(00); Grant AF-AFOSR-474-67)
(AD-672357)

Contents: Summary of research: Superconducting properties and anisotropic electrical resistivities of pure and cadmium-doped tin; Superconducting-and normal-state thermal conductivity of impure tin; Energy gap and thermal conductivity of pure and impure superconducting tin; Electrostatic effect and superconductivity in tiny samples; Effect of the superconducting energy-gap anisotropy on the thermal conductivity of tin; The effect of antimony, indium and zinc impurities on the critical field surve of tin; Anisotropy of the residual resistivity of tin with Sb, In, Zn and Cd impurities, and the ideal resistivities and deviations from Matthiessens rule at 77 and 273 degrees K; Measurement of the orientation of tin single crystals by optical means; Depression of indium superconducting transition temperature by Holmium and Gadolinium. TAB

N68-34606# Cornell Univ., Ithaca, N. Y. Materials Science Center.
ELECTROLUMINESCENCE IN GaAs BY TUNNEL INJECTION OF MINORITY CARRIERS
Lawrence Jay Rosenkrantz Jun. 1968 159 p refs
(Contract DA-31-124-ARO(D)-364)
(MSC-934; AROD-5560.7-E; AD-672524)

Experiments have been carried out to observe the recombination radiation which results from the tunnel-injection of minority carriers into a degenerately doped single crystal of Gallium Arsenide. Electroluminescence was observed in the 1.49 eV spectral region at 4 degrees K and 77 degrees K. A theoretical model was proposed to explain the observed luminescence which involved the assumption that holes tunnel into the GaAs valence band through a barrier of magnitude Psi sub h, and that electrons simultaneously tunnel out of the GaAs conduction band through another barrier of magnitude Psi sub e. Using the Bethe-Sommerfeld tunneling model, but neglecting the image force term, the effective magnitudes of Psi sub e and Psi sub h were determined by fitting the theoretical hole and electron tunneling expressions to similar expressions constructed from the observed data. In order to explain the data it was found necessary to modify the original model to include the effect of pinholes in the insulating film. When so modified the theory adequately explains the luminescence and I(V) behavior of the MIS wafer. Author (TAB)

N68-34812# Wayne State Univ., Detroit, Mich.
ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIATION INDUCED DEFECTS IN SINGLE CRYSTALS OF LITHIUM SULFATE
Clifford L. Aseltine (Ph.D. Thesis) 1967 119 p refs
(Contract AT(11-1)-1054)
(COO-1054-39) CFSTI: HC $3.00/MF $0.65

Single crystals of $Li_2SO_4 \cdot H_2O$ were grown with labeled Li and H isotopes near room temperature and irradiated in 1-MeV electron beams near 77°K. EPR spectra measured without warming the sample were anisotropic with resolved proton (or deuteron) hyperfine structure. It is concluded that the defect of axial symmetry responsible for the spectra is probably an OH radical with insignificant bonding to its neighbor. When the same samples were warmed to room temperature and again returned to 77°K, the OH radical spectrum disappeared, and two new types (B and C) of spectra were observed. Type B was identified as a modification of the original OH radical. Type C was attributed to an oxygen radical of the form O^-_2 formed simultaneously with the O_2H radical. Similar results were produced by gamma irradiation. Crystals irradiated by thermal neutrons produced types B and C spectra and also three new types of spectra. One of these new spectra was assigned to an O^-_2 radical with increased ground-state splitting. The other two were attributed to SO^-_4 radicals trapped in different environments. NSA

N68-34681# Purdue Univ., Lafayette, Ind. School of Aeronautics, Astronautics, and Engineering Sciences.
RELATIVISTIC CONTINUUM PHYSICS OF MATERIALS WITH MEMORY. THERMODYNAMIC RESTRICTIONS
Howard D. Curtis and George Lianis Jan. 1968 84 p refs
Its Res. Proj. No. 5247
(Contract NSF GK-1969)
(AA+ES-68-1)

The authors extend the results of Coleman's thermodynamic theory of simple materials to simple materials exhibiting electromagnetic, as well as mechanical and thermodynamic, memory. To this end, recent results in relativistic continuum physics are employed. It is shown that certain of the constitutive functionals are obtained by applying linear differential operators to the free energy functional. Author

N68-34687# American Optical Co., Southbridge, Mass. Research Group.
ESR AND OPTICAL ABSORPTION STUDIES OF TRANSITION METAL IONS AND COLOR CENTERS IN GLASS Semiannual Technical Report, 1 Oct. 1967–31 Mar. 1968
Robert J. Landry and Joseph T. Fournier Jul. 1968 41 p refs
(Contract N00014-67-C-0186; ARPA Order 306)
(TR-599-3; AD-672549)

Research efforts in the following areas are summarized: Isolated Cr(3+) ions in glass; Exchange coupled Cr(3+) ions in glass; Isolated Cu(2+) ions in silicate glass; Room temperature stable color centes defects in laser glass; Transient color centers; M.O. theory - CNDO approximation; Application to SiO4 tetrahedra; Evaluation of matrix elements. TAB

N68-34703# Frankford Arsenal, Philadelphia, Pa. Pitman-Dunn Research Labs.
OPTICAL PROPERTIES OF ELECTRONS IN METAL
Robert J. Esposito May 1968 206 p refs
(FA-R-1889; AD-672481)

Utilizing the Bohm-Pines formulation, we have calculated the optical absorbing power to second order of a high density electron gas in the long wavelength limit. The optical properties of the electron gas contained within a thin slab are shown to be markedly different from those of a bulk gas, provided that the lifetime of the excited particles is sufficiently long for the particles to feel their containment within the slab. We discuss bulk and thin film absorption processes which are predicted to be within the range of experimental observation in certain free electron-like materials, such as the alkali metals and n-doped semiconductors. The possible utilization of these predicted phenomena for laser intensity detection over a wide spectral region is briefly discussed. Author (TAB)

N68-34717# Ballistic Research Labs., Aberdeen Proving Ground, Md.
ULTRASONIC PROBING OF PLASTIC WAVES
Thomas W. Wright May 1968 38 p refs
(BRL-1400; AD-672058)

Experimental studies of wave propagation in metals have used almost exclusively a variety of surface measurements from

which internal characteristics have been deduced. Based upon speculations concerning the behavior of a small amplitude oscillation in the presence of a finite plastic wave, this report examines the possibility of reflecting an ultrasonic pulse off a large plastic wave front. By examining the echo return, one could deduce information concerning the characteristics of the finite wave and thus have means of probing internally. Author (TAB)

N68-34741# Wayne State Univ., Detroit, Mich.
THE BEHAVIOR OF THE CRITICAL FIELD OF QUENCHED THIN Pb, Sn, AND In FILMS: ITS ANGULAR DEPENDENCE AND ITS RELATION TO CHANGES IN DEFECT CONCENTRATION, CRYSTALLIZATION, AND MEAN FREE PATH
Charles K. Schiller (Ph.D. Thesis) 1968 104 p refs
(Contract AT(11-1)-1054)
(COO-1054-41) CFSTI: HC$3.00/MF$0.65

The critical field behavior of superconducting thin films of Pb, Sn, and In, quenched on substrates held at liquid He temperatures, was investigated. The experimentally determined angular dependence of the critical field, H_c, was compared with the prediction of the Tinkham theory, which also provided a means for estimating the electronic mean free path, l, from the measured critical field values. These l values are compared with the nominal crystallite sizes for similarly formed films as determined by electron-diffraction experiments performed by Bulow and Buckel. The films were formed by quenching the metal vapor on a perpendicular-cut quartz single-crystal substrate held at liquid He temperature. After the evaporation process, measurements were begun of the dependance of H_c on θ, where θ is the angle between the field and the plane of the film. The transition was measured resistively, using currents of 0.80 mA, orthogonal to the field and normal to the film. Author (NSA)

N68-34742# Akademiya Nauk URSR. Kiev. Institut Teoreticheskoi Fiziki.
MOTION EQUATIONS FOR DENSITY OF THE FERROELECTRIC MAGNETIC MOMENT, RELAXATION OF NUCLEAR SPINS OF A FERROMAGNETIC SYSTEM [URAVNENIYA DVIZHENIYA DLYA PLOTNOSTI MAGNITNOGO MOMENTA FERRODIELEKTRIKA RELAKSATSIYA YADERNYKH SPINOV FERROMAGNITNOI SISTEMY]
E. G. Petrov 1968 27 p refs In RUSSIAN
(ITF-68-6)

Using the nonequilibrium density matrix, the motion equations are obtained for the magnetization of the ferrodielectric as well as those for nuclear spins of impurity atoms of a ferromagnetic system. The relaxation time is calculated for the longitudinal and transverse components of the magnetization. It is shown that the relaxation time for nuclear spins and corrections to vibration frequencies are determined by the exact correlation functions describing fluctuations of the magnetic induction. Author (NSA)

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N68-33624# Catholic Univ. of America, Washington, D. C. School of Engineering and Architecture.
STRESSES IN A SPLIT CYLINDER BONDED TO A CASE AND SUBJECTED TO RESTRAINED SHRINKAGE
A. J. Durelli, V. J. Parks, and Han-Chow Lee Jan. 1968 30 p refs Sponsored by the Office of Naval Res.

A specific propellant geometry, chosen to minimize the stresses and strains due to restrained shrinkage, is considered. The grain geometry has two features: (1) A star shaped slot with two tips divides the grain in half. (2) A notch, in the nature of a stress relief, is located along the perimeter of the bonded interface of grain and shell. A three-dimensional photoelasticity method is used to obtain maximum shear stresses at any point in the field and maximum principal stresses on free boundaries. Slices were made of an epoxy model cast in a steel shell. Stress results are depicted on the analyses of the free surfaces, meridian slice, and 45° meridian slice, and are found highest in the relief groove at the head end of the grain body, and in the area of the bonded interface nearest the groove point with the highest stress. B.P.

N68-33979# Explosives Research and Development Establishment, Waltham Abbey (England).
PARALLEL PLATE PLASTOMETRY OF PLASTIC PROPELLANT. PART 1: DETERMINATION OF YIELD STRESS
W. A. Dukes 30 Nov. 1967 33 p refs
(ERDE-14/R/67; WAC/179/09; AD-669423)

Various theoretical analyses of the equilibrium compression between parallel plates of cylindrical specimens of plastic materials have been compared with the experimental behaviour of plastic propellants. Three theories have been shown to be inapplicable, but one, due to Meyerhof and Chaplin, agrees well with experiment. Thus, the fundamental rheological property of yield stress may now be derived from this simple test, independent of the dimensions of the specimen. It also has been shown that a particular propellant, RD 2428/T2, strain-hardens linearly: that is, the yield stress is a linear function of the strain over a wide range. Author (TAB)

N68-34451# Plastics Technical Evaluation Center, Dover, N. J.
COMPATIBILITY OF EXPLOSIVES WITH POLYMERS (2)
Norman E. Beech and Vincent K. Canfield Apr. 1968 81 p
(PLASTEC-33; AD-672061)

The work reported covers the explosives/plastics compatibility data from 1959 through 1967. The effort has been to include all available hard data from the United Kingdom, Canada, Australia and these United States. The study is given a simplified form: in alphabetical order (first) by trade name or generic name of the plastic and (second) by explosive. By this means the reader can tell (first) what explosives a plastic is compatible with and (second) what plastics can be used safely with a particular explosive. For this report, the search was expanded to include adhesives and elastomers. Author (TAB)

N68-34757*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE EFFECT OF VARIOUS PROPELLANTS AND PROPELLANT MIXTURES ON AN MPD ARC JET
P. Brockman, J. Burlock, R. V. Hess, and F. W. Bowen [1967] 13 p refs Presented at the AIAA Joint Elec. Propulsion and Plasmadyn. Conf., Colorado Springs, 11–13 Sep. 1967
(NASA-TM-X-60513) CFSTI: HC$3.00/MF$0.65 CSCL 21C

Independent measurements of the velocities of ions and neutrals were made, along with observations of other changes in arc and plasma jet characteristics due to variations in propellant mixtures, total mass flow, current, and magnetic field. Correlations of axially and azimuthally propagating coherent fluctuations were used to measure arc jet velocities; time-of-flight methods were used to measure the propagation of natural disturbances in the plasma jet. The differences between the propagation of fluctuations in ion density, potential, and light are evaluated. These velocity measurements are compared with those obtained from thrust and mass flow for various gas mixtures, currents, and magnetic fields. The distribution of electric fields in the plasma jet is also studied, including steady as well as fluctuating components and its dependence on propellant mixtures and other parameters. Author

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N68-33954 Iowa State Univ. of Science and Technology, Ames.
A GENERALIZED METHOD FOR THE DESIGN OF OPTIMUM ROCKET NOZZLES
Harvey Lee Rozendaal (Ph.D. Thesis) 1967 207 p
Available from Univ. Microfilms: HC $9.45/Microfilm $3.00 Order No. 67-12991

In this study the Steepest Descent optimization technique is used in conjunction with a Characteristics Method of flow field computation to design the supersonic portions of De Laval rocket nozzles. The optimum nozzle shape is determined by improving, in a stepwise fashion, an arbitrarily selected nominal shape which, in general, neither maximizes the specified performance variable nor meets the specified constraints. To demonstrate the feasibility of optimizing rocket nozzles using the Steepest Descents Method, a digital computer program was developed and several different cases were analyzed. An automatic convergence control system is incorporated into the computer program to speed up convergence and at the same time lessen the possibility of false convergence. Dissert. Abstr.

N68-33995*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AUTOMATIC CONTROLS FOR FACILITIES AND MERCURY ION THRUSTERS IN DURABILITY TESTING
C. R. Nichols and S. J. Obloy Washington 1968 15 p refs
Presented at the 4th Propulsion Joint Specialist Conf., Cleveland, 10–14 Jun. 1968; Sponsored by AIAA
(NASA-TM-X-52427) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Changes to vacuum chamber systems and the use of thruster control circuits are described which permit operation with reduced manpower. The vacuum chambers range in size from 1.5 to 7.6 meters in diameter with 8.5 to 850 cubic meters in volume. These chambers use normal roughing, oil-diffusion, and cryopumping systems. Chamber pressure, with thrusters operating, is typically in the 10^{-7} torr range. Changes to these facilities are described which provide for automatic shutdown during unattended operation. Thruster controls are described that allow continuous testing of ion thrusters for almost three months with only one man per shift. Additional thruster controls and tank modifications now permit unattended durability testing. Author

N68-34C23*# Colorado State Univ., Fort Collins. College of Engineering.
ADVANCED ELECTRIC PROPULSION RESEARCH Semiannual Report, 31 Dec. 1967–30 Jun. 1968
William R. Mickelsen 30 Jun. 1968 108 p refs
(Grant NGR-06-002-032)
(NASA-CR-96633; MER-68-69WRM-11; Rept.-7) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Missions for auxiliary electric propulsion are reviewed, including difficult future missions. The present status of electric propulsion applications is summarized. This summary includes electric propulsion systems in missions already flown and in definitely scheduled flights through 1969. Some advanced concepts are described that have promise of providing superior performance. These advanced concepts include thermal augmentation of resistojets for MORL class spacecraft, supersonic power addition in electrothermal thrusters, higher-voltage solar-cell arrays for charged-particle thrusters and for bombardment thruster systems, and radioisotope electrogenerators for charged-particle thrusters and for pulsed-plasma thrusters. Author

N68-34038*# Chrysler Corp., New Orleans, La. Space Div.
FINAL S-IB-5 PROPULSION SYSTEM, FLIGHT PERFORMANCE PREDICTIONS FOR LAUNCH MONTHS AUGUST THROUGH DECEMBER
R. M. Cordes 15 Jun. 1968 34 p
(Contract NAS8-4016)
(NASA-CR-96544; TR-P+VE-68-65) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The final flight performance prediction data for the Saturn AS-205 propulsion system, S-IB-5 stage are presented. Data are determined by simulating the first stage powered flight of Saturn AS-205 with the Mark IV computation procedure. Analysis of the data for the five launch months under consideration (August through December) indicate that inboard engine cutoff will occur between 140.05 and 142.22 seconds after first motion. Outboard engine cutoff is expected three seconds later than the respective inboard engine cutoff time. These times are based on the defined fuel and LOX load specific weights and stage propellant fill weights for each of the five months. Author

N68-34079*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
PROPELLANT SELECTION FOR SPACECRAFT PROPULSION SYSTEMS. VOLUME 3: THERMODYNAMICS AND PROPULSION Final Report
30 Aug. 1968 163 p refs
(Contract NASw-1644)
(NASA-CR-96740; K-19-68-6, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Technical details of the thermodynamic analyses and the propulsion system analyses performed during the Propellant Selection Study are presented. Thermodynamic analyses were conducted to determine spacecraft thermal control and pressurization requirements for the Mars Orbiter and Mars Excursion Module (MEM) missions. The scope and depth of the thermal studies were sufficient to provide valid performance between candidate propellants. The analyses involved the computation of heat transfer to and/or from the propellant, such as heat from the external environment, other parts of the spacecraft, or from the pressurizing gas injected into the tanks. Because of the interaction between the pressurization system and system thermal behavior, pressurization and thermal analyses could not be conducted independent of one another, and were therefore integrated. The tank operating pressure levels and insulation requirements that were established were based upon the heat transfer and resulting propellant response. Author

N68-34189# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Inst. für Strahlantriebe.
ON THE SUPPLY OF FLUID AND GASEOUS MEDIUMS IN SUPERSONIC STAGES [UBER DIE ZUFUHR VON FLUSSIGEN UND GASFORMIGEN MEDIEN IN UBERSCHALLSTRECKEN
Michael Kallergis Mar. 1968 65 p In GERMAN; ENGLISH summary
(DLR-FB-68-26) CFSTI: HC $3.00/MF $0.65

For the investigation of the fuel injection into a supersonic Ma-3 air stream, as in supersonic combustion chambers, liquid and gaseous fuels were injected into the stream through nozzles and tubes. For injection perpendicularly to the mainflow the blast waves and the jet penetration in the near-injection zone were determined. The injection pressures are varied for kerosene and air between 0 and 40 atmospheres and for hydrogen between 0 and 120 atmospheres. To eliminate the influence of the wall boundary layer the tubes and the nozzles are projecting a short length into the

mainflow. In the case of injection through wall bores on the one hand the influence of the boundary layer was considered and on the other hand this influence could be eliminated by use of a wedge arranged in the flow. For liquid injection a method is shown to determine the amount of the fuel which is atomized due to breaking up of the wave crests generated on the surface of the fuel close to the nozzle. Author (ESRO)

N68-34190# Société pour l'Etude et la Réalisation d'Engins Balistiques, Courbevoie (France). Direction Technique.
ELDO STUDY NO. 8.2: ADDITION OF SOLID BOOSTERS TO BLUE STREAK. FEASIBILITY STUDY [ELDO ETUDE NO. 8.2: ADJONCTION DE BOOSTERS A POUDRE SUR LE BLUE STREAK. ETUDE DE FAISABILITE]
8 Feb. 1968 101 p In FRENCH Prepared for ELDO
(DTA/3-NO.30/9539) CFSTI: HC$3.00/MF$0.65

This preliminary study is concerned with the feasibility of an ELDO launch vehicle having two large solid boosters strapped on a Blue Streak. Stationary orbits would require an H 15 hydrogen/oxygen engine and an apogee motor as upper stage. Propulsion, structure, control, aerodynamics, guidance and separation problems of the boosters are outlined as well as a preliminary definition of the launch vehicle with either 120 t or 170 t boosters. ESRO

N68-34192# European Space Vehicle Launcher Development Organization, Paris (France).
ELDO TECHNICAL REVIEW, VOLUME 2, NO. 3 AND 4
Gauthier-Villars 1967 138 p refs In FRENCH and ENGLISH Presented at the ELDO Symp. on Propulsion, Paris, 10–12 Oct. 1967
CFSTI: HC$3.00/MF$0.65

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2. INTEGRAL TANKS OF THE CRYOGENIC STAGE H3.5 J. Menard (L'Air Liquide) and M. Segel (L'Air Liquide) p 137–157 (See N68-20400 10-28)
3. THE DESIGN AND MANUFACTURE OF A LIQUID HYDROGEN THRUST CHAMBER T. E. Steer (Rolls Royce) p 159–181 (See N68-15158 06-28)
4. HIGH ENERGY UPPER STAGES FOR ELDO VEHICLES G. W. Childs (Hawker Siddeley Dyn.) and D. Stott (Hawker Siddeley Dyn.) p 183–206 (See N68-20307 10-28)
5. ADVANCED HYBRID PROPELLANTS B. Crampel (ONERA) p 207–248 (See N68-20392 10-28)

N68-34239# European Space Vehicle Launcher Development Organization, Paris (France).
THE ELDO-PAS PROGRAM AND ITS MANAGEMENT
J. Nouaille *In* ESRO/ELDO Bul. No. 1 May 1968 p 6–11 (See N68-34238 21-31)

The technical content of the ELDO-PAS, perigee and apogee propulsion system, program covering the development of a solid propellant fourth stage for the Europa launcher for transformation into the Europa II launcher, a test satellite and tracking network is described. The project management procedures are also outlined. ESRO

N68-34315*# Emerson Electric Co., St. Louis, Mo. Electronics and Space Div.
COMPILATION OF ROCKET SPIN DATA. VOLUME 2: LITERATURE SURVEY Final Report, Nov. 1966–Aug. 1968
Leo J. Manda 22 Jul. 1968 92 p refs For Vol. 1 see N68-25842
(Contract NAS1-6833)
(NASA-CR-66641; Rept.-3001-2) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Data compiled from more than 200 reports of motor development tests and research studies indicate that a solid propellant rocket motor operating in a spin environment can exhibit gross deviations from static performance, depending upon spin rate, propellant formulation, and motor configuration. The usual increases in operating pressure and reductions in burn time experienced under spin are shown to be functions of both (centrifugal) acceleration effects on the combustion process and spin effects on combustion chamber and nozzle gas dynamics. Analytical attempts to predict these performance anomalies have shown qualitative agreement with experimental trends, but generally fail to provide quantitative estimates of the effects of the many complex phenomena involved in the gas evolution and flow processes. Author

N68-34354*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A HOT GAS GENERATOR FOR LARGE SCALE SUPERSONIC COMBUSTOR TESTING
A. J. Metzler and E. A. Lezberg Washington 1968 11 p refs Presented at the 4th Propulsion Joint Specialist Conf., Cleveland, 10–14 Jun. 1968 Sponsored by AIAA
(NASA-TM-X-52433) CFSTI: HC$3.00/MF$0.65 CSCL 21H

Theoretical calculations indicate a N_2H_4–N_2O_4 rocket operating at an O/F of 3.0 can simulate the temperature and pressure requirements for direct-connect testing of large-scale Scramjet combustors at conditions simulating altitude flight at Mach 8. Combustor inlet gases would contain 21 percent oxygen with nitrogen and water vapor as inert components. Preliminary rocket performance tests indicated C* efficiency of 98 percent and acceptable temperature and mass flow profiles. Limited data support the feasibility of the gas generator combustor test concept. Author

N68-34355*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH PERFORMANCE BYPASS CONTROL FOR MIXED-COMPRESSION INLETS
Michael J. Crosby, George H. Neiner, and Gary L. Cole Washington 1968 12 p refs Presented at the 4th Joint Propulsion Specialist Conf., Cleveland, 10–14 Jun. 1968 Sponsored by AIAA
(NASA-TM-X-52439) CFSTI: HC$3.00/MF$0.65 CSCL 21H

Results from investigations of normal shock and restart control systems utilizing 100 Hz bypass doors and 250 Hz pressure transducers are presented. Included are analyses followed by experimental results obtained from a 25-inch translating-centerbody inlet tested at a Mach number of 2.5 in a 10- by 10-foot wind tunnel. The normal shock control systems were subjected to downstream and upstream flow disturbances from 0 to 140 Hz and 0 to 20 Hz, respectively. Large amplitude transients were also investigated. The inlet was terminated alternately with a large volume, a choked orifice at the engine face station, and a J-85-13 turbojet engine. The normal shock controllers investigated indicated increased performance with electronic compensation and use of multiple feedback. The restart controllers maintained closed-loop bypass door control throughout the restart cycle. This minimized total pressure variations at the engine face station. Author

N68-34418*# Colorado State Univ., Fort Collins.
POWER NEEDS FOR ELECTRIC PROPULSION
William R. Mickelsen Aug. 1968 10 p refs Presented at the 3rd IECEC Conf., Boulder, Colo., 13–16 Aug. 1968
(Grant NGR-06-002-032)
(NASA-CR-96819) CFSTI: HC$3.00/MF$0.65 CSCL 21C

The present status and future trends of electric propulsion systems and missions are briefly reviewed. Some typical electric propulsion systems are described. These cover a thrust range from 20 micropounds to 65 millipounds, and are intended for space missions ranging from satellite attitude control to primary propulsion for interplanetary unmanned vehicles. Electric power needs for electric propulsion systems are summarized in terms of three general mission classes: auxiliary, intermediate, and primary propulsion.

Power needs are listed for those thruster systems that appear suited to each particular mission. Author

N68-34694 Hawker Siddeley Dynamics, Ltd., Hatfield (England). Space Projects Div.
STUDY OF ELECTRICAL PROPULSION FOR THE TRANSFER OF PAYLOADS FROM LOW TO SYNCHRONOUS ORBITS
Dec. 1967 145 p refs Prepared for ELDO
(Contract-CTR-17/7/23)
(HSD-TP-7091)

Several types of electric propulsion units have been examined, in order to evaluate the performance potential and engineering feasibility for ELDO requirements of payload transfer from low to synchronous orbits. For transfer times up to 100 days the resistojet provides the best potential performance, and for transfer times above 100 days, the mercury bombardment ion thruster is the better choice. ESRO

N68-34725*# National Aeronautics and Space Administration, Washington, D. C.
TEST OF 260-INCH DIAMETER MOTOR SL-3
William Cohen Jun. 1968 6 p Presented at the 3rd ICRPL/AIAA Solid Propulsion Conf., Atlantic City, 4–6 Jun. 1968
(NASA-TM-X-61238) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The manufacture and test of the large solid rocket motor SL-3 has resulted in the following accomplishments: (1) a nozzle of ablative composite design for thrust near 6M pounds has been demonstrated for duration of 80 seconds, with enough data generated on ablation and erosion to support the conclusion that durations of more than 2 minutes will be possible; (2) the submerged structure and the surrounding insulation for a moving nozzle type of vector control system has been evaluated, with similar conclusions about burn time; (3) the key elements of a burn-through detection and warning system have been tested, verifying the concept under the limitation of short circuit path; (4) the manufacture method for inert slivers for large motors has been established; (5) the reuse of insulation has been demonstrated; and (6) the requalification and reuse of large motor cases made of marage steel has been shown. On the negative side, the SL-3 test has shown that deeper understanding of the processing methodology of large multi-batch motors must be obtained, in relation to the flow and viscosity properties measured in the laboratory. Author

N68-34750*# National Aeronautics and Space Administration, Washington, D. C.
REQUIREMENTS FOR SPACE PROPULSION SYSTEMS
Ward W. Wilcox and Robert H. Rollins, II [1968] 63 p
(NASA-TM-X-61186) CFSTI: $3.00 CSCL 21H

Environmental and performance parameters that will affect the specifications for future spacecraft propulsion system development are discussed. Nuclear, solid, electric, and hybrid propulsion systems are mentioned, with emphasis placed on the advantages of the liquid rocket systems. Storage temperature tolerance of three broad classes of propellants are considered: earth storable (650° to 470° R), space storable or mild cryogenic (300° to 90° R), and the deep cryogenic liquid hydrogen (50° to 25° R). Performance characteristics of some typical propellant combinations are graphed, and propellant liquid ranges are compared. Pertinent parameters are given for future missions, and the wide variation in trip time and propulsion system weight requirements are examined. M.G.J.

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N68-33689 Louisiana State Univ., Baton Rouge.
A SEA LEVEL COSMIC RAY SEARCH FOR FAST SMALL POLE STRENGTH MAGNETIC CHARGES
Philip Joseph Green, II (Ph.D. Thesis) 1967 110 p
Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-13986

The Cerenkov emission for a fast magnetic charge is enhanced by the refractive index squared relative to that for a similar pole strength electric charge, whereas the ionization energy loss is expected to be the same. This experiment distinguished fast magnetic charges by comparing the Cerenkov and scintillation pulse amplitudes from single particles. A Lucite Cerenkov counter (1/4 m^2 area) was sandwiched between two plastic scintillation counters and accepted 0.027 steradians. Discriminators accepted only events in which the scintillation pulses matched within 70% to 30% from .7x to 2x minimum ionization respectively. The two scintillation counter pulses were added to provide a single measure of the ionization energy loss for comparison with the Cerenkov pulse. Two 1/4 m^2 side shower counters discriminated against extensive air showers. The two pulse amplitudes were analyzed by a pulse height analyzer and recorded onto paper tape for computer data analysis. Dissert. Abstr.

N68-33779 Rochester Univ., N. Y.
A STUDY OF THE ISOTOPIC COMPOSITION OF LOW-ENERGY HYDROGEN AND HELIUM NUCLEI IN THE PRIMARY COSMIC RADIATION
Gautam Dev Badhwar (Ph.D. Thesis) 1967 175 p
Available from Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-13609

The results obtained from two balloon flights of a dE/dx x E counter-telescope, designed to measure the isotopic composition of low energy primary cosmic ray hydrogen and helium nuclei are presented. The differential energy spectra of protons, deuterons, He^3 and He^4 in the approximate energy range of 60–220 Mev/n has been obtained. The results indicate a constant ratio of p/He^4 of 4.3 ± 1.0 as a function of energy per nucleon in the above energy region. An upper limit of 0.25 on H^2/He^4 has been obtained at 150 Mev/n. This indicates, on the basis of a simple slab approximation, an upper limit of 6 g/cm^2 of hydrogen traversal by the primary radiation at this energy. A ratio of $He^3/He^3+He^4 = 9.4 \pm 1.7\%$ has been obtained in the energy range of 78-220Mev/n. From a comparison of proton and helium spectra obtained in the present experiment with the existing data for 1965, it is found that a modulation function proportional to $R\beta$ is favoured over other forms predicted by Parker's model. Dissert. Abstr.

N68-33848 Arizona Univ., Tucson.
THE EFFECT OF PHOTOSPHERIC INHOMOGENEITIES ON THE EMERGENT RADIATION FIELD OF THE SUN
Thomas Ewing Margrave, Jr. (Ph.D. Thesis) 1967 179 p
Available from Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-16518

The main purpose of this dissertation is to take account of this inhomogeneous structure in constructing a non-gray blanketed model photosphere which is in radiative equilibrium throughout its upper layers. The goal is to achieve better agreement between the predicted and observed emergent continuum radiation fields of the sun than has been exhibited by previous theoretical model photospheres. Previous efforts by other authors to construct inhomogeneous model photospheres are recounted. The major characteristics of each model are described, and the resultant fit between the predicted and observed emergent continuum radiation fields is discussed in the cases for which the necessary data were available. Relaxation of the pressure-equality requirements is an essential characteristic of the inhomogeneous models constructed here. The method adopted here for incorporating inhomogeneities into a model photosphere is the two-column approach in which the photosphere is assumed to consist of numerous vertical columns of two different types. Dissert. Abstr.

N68-33855 California Univ., Davis.
A SELF-CONSISTENT CALCULATION OF THE EARTH'S RADIATION BELTS
John Cummins Baker (Ph.D. Thesis) 1967 40 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-14959

Attempts to calculate self-consistently the pressure, current, and magnetic fields from a two-dimensional model of the earth's radiation belts were made. Consideration is also given to the following four questions. (1) Is self-confinement possible? (2) How much plasma can the earth's field support if self-confinement is not possible? (3) Does the plasma magnetic field aid or oppose the earth's magnetic field at the equator? (4) Is it possible for the magnetic field to reverse direction inside the radiation belt? Dissert. Abstr.

N68-33889 Michigan Univ., Ann Arbor.
THE REFLECTANCE AND SCATTERING OF SOLAR RADIATION BY THE EARTH
Frederick Lester Bartman (Ph.D. Thesis) 1967 283 p
Available from Univ. Microfilms: HC $12.85/Microfilm $3.65 Order No. 67-15592

The basic objective of this study is to provide a complete analysis of the physical and observational problems associated with the determination of the earth's albedo. There are two main results of this analysis: One is the conclusion that, insofar as the reflectance of solar radiation is concerned, the earth is a nonhomogeneous body with its various regions having different diffuse, wavelength dependent reflectance functions. The second is a statement of the geometrical-physical characteristics of a precise model for the calculation of earth's albedo. The nature of the earth's reflectance is explored by means of precise definitions, a complete survey and critical analysis of existing research results, and new earth reflectance data obtained by radiometer measurement on three high altitude balloon flights. The precise model is obtained by careful detailed application of the precise definitions. Dissert. Abstr.

N68-33953 Purdue Univ., Lafayette, Ind.
SOLAR LOOP PROMINENCES, A THEORETICAL MODEL
Carl Adelbert Olson (Ph.D. Thesis) 1967 54 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-16694

A theoretical model of the loop prominence flare event is given, in which the compression by the magnetic fields which may cause the solar flare is also made to cause the loop prominence. This model is based on the condensation theory of prominences in which a plasma compressed by a magnetic field loses heat by conduction and radiation. The model is used to get time height graphs of the loop prominence flare event which show good agreement with observations up to altitudes of about 30,000 km. This is done for compression times of 500 to 1000 sec. The family of curves in the time height graphs are obtained by varying the initial temperatures. It is shown that the way in which the final density was reached during the compression, or using various types of compression, did not significantly affect the results. Condensation theories have been criticized in the past due to the difficulties of supplying sufficient mass. It is shown in the present model that sufficient mass for the region in which the model is valid can be supplied from the coronal condensation. Since the model in question seems to be valid only for the lower loops of the loop prominence system, it is suggested that the fast particle theory of loop prominences might be valid in the higher regions. Dissert. Abstr.

N68-33964# Pennsylvania State Park, University Park. Dept. of Astronomy.
A MODEL FOR SOLAR CONTINUUM RADIO BURSTS WITH AN APPLICATION TO THREE EVENTS
William M. Barney 4 Jun. 1968 72 p refs
(Grants NSF GP-2986; NSF GA-720)
(SR-013)

The observed and evaluated spectra of several solar radio bursts are consistent with the following model for the radio burst producing region. The region responsible for the excess continuum radiation can be assumed to be an expanding, isothermal, homogeneous isotropic region containing a mixture of thermal plasma and relativistic electrons with an energy distribution $N(E)\,dE \propto E^{-\beta}\,dE$, where β is generally between 7 and 12. There is evidence to believe that during injections the value of β may be 5 or lower. The magnetic fields were assumed to be constant throughout the region; however, the angle was assumed to be randomly distributed. The mechanisms which contribute to emission and absorption are thermal bremsstrahlung and synchrotron processes. Author

N68-34008# Imperial Coll. of Science and Technology, London (England). Dept. of Physics.
THE SECOND HARMONIC OF THE COSMIC RAY DAILY VARIATION
J. J. Quenby and B. Lietti [1967] 21 p refs Sponsored in part by ESRO
CFSTI: HC $3.00/MF $0.65

Since on the Parker model for the quiet interplanetary magnetic field the spirals are less tightly wound at high solar latitudes, cosmic rays arriving along the sun's polar field lines may suffer less modulation than those arriving in the ecliptic plane. Hence a rising cosmic ray density gradient is expected away from the solar equatorial plane which gives rise to a second harmonic variation with maxima at right angles to the spiral field direction. A model for the density gradient is considered in which particle diffusion is important only along the field direction and the resulting second harmonic varies as the first positive power of magnetic rigidity in the range 1→15 GV. This is shown to be in reasonable accord with experimental results over the solar cycle from 1957 to 1964. Author (ESRO)

N68-34059*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TEMPORAL VARIATIONS OF THE 100 KEV TO 1700 KEV TRAPPED PROTONS OBSERVED ON SATELLITE EXPLORER 26 DURING FIRST HALF OF 1965
F. Sorass and L. R. Davis Aug. 1968 52 p refs
(NASA-TM-X-63320; X-612-68-328) CFSTI: HC $3.00/MF $0.65
CSCL 04A

The temporal behavior of 100 keV geomagnetically-trapped protons in the region 2 to 5.5 earth radii for the period 29 January through 29 June 1965 was determined using data from a scintillation detector on Explorer 26. The results exhibit both adiabatic changes which vary directly with the magnetic field (Dst) and nonadiabatic changes which do not track the field. The adiabatic variations, which result from slow changes in fields during which all three adiabatic invariants are conserved, can be removed by transforming the measurements from the time dependent field to a reference field. The transformation was computed for protons mirroring on the equator using a disturbance field, $B(t, L) = C \cdot Dst(t) \cdot f(L)$ where C is a constant (≈ 0.7) that corrects for the induction field of the conducting earth, t is the time of observation and f(L) is the radial dependence for a model ring current field. The transformation reduces the regression coefficients of proton intensity on Dst by a factor of 5 or more out to $L = 4.5$. The transformed data clearly show nonadiabatic variations. The protons underwent rapid changes during magnetic storms. Author

N68-34064# Kiruna Geophysical Observatory (Sweden).
AURORAL PARTICLE MEASUREMENTS AT KIRUNA GEOPHYSICAL OBSERVATORY
Bengt Hultqvist *In* ESRO Bull. No. 4, 1967 p 17–18 (See N68-34062 21-30)

Sounding rocket and satellite experiments were carried out to observe spectral peaking in the range from 50 to 100 keV and

to measure more energetic protons and alpha particles, which are emitted by some very intense solar flares and which cause very strong effects in the lowest ionosphere (polar cap absorption effects). ESRO

N68-34065# Space Research Lab., Utrecht (Netherlands).
SOLAR AND STELLAR RADIATION INVESTIGATION AT THE SPACE RESEARCH LABORATORY, UTRECHT
W. de Graaff *In* ESRO Bull. No. 4, 1967 p 19–21 (See N68-34062 21-34)

The general scope of the Utrecht solar research program comprises the analysis of electromagnetic radiation with respect to both spectral composition and to spatial distribution for the quiet sun, as well as for active regions during the various stages of their development, and furthermore the flux densities of charged particles with various energies. Experiments for solar radiation measurements included in ESRO sounding rocket payloads and ESRO satellites are described. One experiment for determination of stellar spectra between 3000 and 2000 Å has been proposed for incorporation in the ESRO-I satellite. ESRO

N68-34118# Institut d'Aéronomie Spatiale de Belgique, Brussels.
SIMPLIFICATIONS IN THE STUDY OF THE GEOMETRY OF PYRHELIOMETERS AND THEIR CONSEQUENCES [LES SIMPLIFICATIONS INTRODUITES DANS L'ETUDE DE LA GEOMETRIE DES PYRHELIOMETRES ET LEURS CONSEQUENCES]
R. Pastiels *In* WMO Precision of Pyrheliometric Meas. 1967 p 23-27 refs In FRENCH; ENGLISH summary (See N68-34115 21-14)

The contribution of the circumsolar sky radiation is calculated for various pyrheliometers, either completely, or with some simplifications. From the comparison it may be concluded that for measurements of great precision (down to 0.1 per cent) it is necessary to do the complete calculus knowing the values of the parameters describing the luminance of the circumsolar sky. Author (ESRO)

N68-34158*# Volt Technical Corp., Washington, D. C.
VARIATIONS OF SOLAR WIND'S ION FLUXES DURING THE INCREASE OF SOLAR ACTIVITY LEVEL ACCORDING TO THE MEASUREMENT DATA OF "VENERA-2" AND "VENERA-4"
K. I. Gringauz and E. K. Solomatina Greenbelt, Md. NASA. Goddard Space Flight Center 4 Sept. 1968 6 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), vol. 6, no. 4, 1968 p 586–589
(Contract NAS5-12487)
(NASA-CR-96661; ST-PF-SP-10748) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Comparison is made of the results of observations of solar wind fluxes near Earth, obtained from Venera 2 in 1965, and Venera 4 in 1967. Conclusion is derived about the increase of solar wind fluxes with the rise of solar activity. Author

N68-34159*# Volt Information Sciences, Inc., Washington, D. C.
SIMULATION OF SOLAR WIND INTERACTION WITH THE EARTH'S MAGNETIC FIELD
G. G. Managadze and Podgornyy 11 Sep. 1968 9 p refs Transl. into ENGLISH from Geomagnetism i Aeronomiya (Moscow), v. 8, no. 4, 1968 p 618–623
(Contract NAS5-12487)
(NASA-CR-96710; ST-PF-GM-10749) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The possibility of simulating the interaction between the solar wind and the Earth's magnetic field is investigated. An accurate simulation of all the processes occurring in the magnetosphere proves to be actually unrealizable. However, there is a possibility of selecting the experimental parameters so as to reproduce under laboratory conditions the most interesting outer space phenomena. The results of experiments on the formation of the neutral sheet are presented as an example of the accuracy of a limited simulation. Author

N68-34286*# Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science.
LOW ENERGY ELECTRONS IN THE MAGNETOSPHERE AS OBSERVED BY OGO-1 AND OGO-3
Vytenis M. Vasyliunas 1967 38 p refs Presented at the Summer Inst., Phys. of the Magnetosphere, Boston, 19–28 Jun. 1967 Submitted for publication
(Grant NsG-386)
(NASA-CR-89092) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Although the first observation of low energy (a few hundred ev to a few kev) electrons in the magnetosphere dates back to the early days of space exploration, detailed studies of these particles have been undertaken only in the last few years. The launch of Vela 2 in July 1964 initiated the first extensive survey of the low energy electron population. Observations with electrostatic analyzers aboard the Vela satellites showed that the low energy electrons form part of a plasma sheet stretching across the tail of the magnetosphere, with a broad, quasi-thermal, non-Maxwellian energy spectrum peaked in the vicinity of 1 kev. However, the orbits of the Vela satellites are circular and hence all their observations are confined to geocentric radial distances near 17 Re (earth radii). A complementary survey of low energy electrons, to study their distribution in radial distance, first became possible a few months after Vela 2, with the launch of OGO-1 into a highly eccentric orbit on September 5, 1964; this satellite carries, among its many experiments, a Faraday cup to detect electrons in the 100 ev–2 kev range. The results obtained with this detector and a similar one flown two years later on OGO-3 are reported. Author

N68-34633*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE GEOMAGNETIC TAIL
Norman F. Ness Sep. 1968 63 p refs
(NASA-TM-X-63330; X-616-68-345) CFSTI: HC $3.00/MF $0.65 CSCL 04A

An overview is presented on the experimental investigations of the earth's magnetic tail and imbedded neutral sheet which established its permanent existence as an extension of the magnetosphere with lines of force closely paralleling the earth–sun line. Physical properties and dynamics of the geomagnetic tail are defined, and a figure is included to depict both the geometry of the tail and the earth's bow shock in cislunar space, as well as the orbits of the satellites used in the experiments. Among the data reported are: (1) The plasma sheet surrounding the neutral sheet appears to be thicker in the center of the tail, flaring to approximately twice that near the dusk and dawn magnetopause boundaries. (2) The tail is still well-defined out to radial distances of 80 R_E although at distances of 500 and 1000 R_E it appears to have broken up into separate filaments. (3) Multiple correlation and regression analysis show that the field magnitude decreases from approximately 16 gamma at 20 R_E to 7 gammas at 80 R_E. M.G.J.

N68-34638# Southwest Center for Advanced Studies, Dallas, Tex.
EFFECT OF THE INTERPLANETARY MAGNETIC FIELD ON THE PROPAGATION OF COSMIC RAYS Final Report, 1 Mar. 1965–31 Aug. 1967
Kenneth G. McCracken Feb. 1968 16 p refs
(Contract AF 19(628)-5028)
(AFCRL-68-0219; AD-672310)

This report presents a study of cosmic-ray propagation in the interplanetary magnetic field using spacecraft and neutron

monitor data. Improved methods have been developed for mapping cosmic ray flux as a function of direction and time. This cosmic-ray mapping technique made possible a detailed study of the Forbush decrease observed on January 20, 1966. Using numerical filtration techniques developed for the purpose, demi-diurnal and diurnal components of cosmic radiation were studied. Two distinctly different anisotropies were identified in the course of studying the interrelationship of cosmic ray anistropy and the interplanetary magnetic field. One anisotropy is due to convective removal of cosmic radiation from the solar system by the radial flow of the solar wind. The other is due to diffusion of the cosmic radiation parallel to the lines of force of the interplanetary magnetic field. Temporal variability of Pioneer VII data during high counting rate periods has been studied. Study of some five days of data indicates continuous fluctuation of the cosmic radiation flux, with periods as short as five minutes occurring frequenctly. No diminution of fluctuation amplitude with time was observed. Author (TAB)

N68-34682*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SATELLITE OBSERVATIONS OF SOLAR RADIO BURSTS

R. G. Stone, H. H. Malitson, J. K. Alexander, and C. R. Somerlock [1967] 6 p Submitted for publication

(NASA-TM-X-60475) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Satellite radio noise measurements in the range 0.5 to 3.0 MHz from above the terrestrial ionosphere showed that numerous solar radio bursts were associated with abrupt enhancements in the low frequency noise levels down to 1 MHz. Time delay measurements between occurrence of bursts at high frequencies and final occurrence at lower frequencies were used to deduce the velocity of the corona disturbances. A projected coronal electron density distribution model has velocities of 0.1 to 0.3 c and temperatures of about 2×10^5°K at 7 Rϕ. If intense noise bursts were associated with complex radio events, the noise level exceeded the background level at least three orders of magnitude; these intense non-thermal radio bursts seemed to be associated with the initial phases of energetic flare-associated events. G.G.

N68-34691# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

ISOTROPIC GAMMA-RADIATION AND THE METAGALACTIC COSMIC-RAY INTENSITY

F. W. Stecker Aug. 1968 7 p refs

(NASA-TM-X-63329; X-641-68-341) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Under various assumptions as to the time-dependence of the metagalactic cosmic-ray flux and the proper cosmological model describing the universe, OSO-3 data are used to place upper limits on the metagalactic cosmic ray intensity. An equation is derived for the differential metagalactic gamma ray flux in a Friedmann-type expanding universe with a Robertson–Walker metric Numerical solutions to this equation were obtained for various models in order to determine the present metagalactic cosmic ray intensity, I_o, needed to produce a gamma ray flux above 100 MeV of 1.1×10^{-4} cm^{-2} sec^{-1} sr^{-1}. The flux, I_o, is tabulated as a fraction of the galactic cosmic ray flux, I_g. The results indicate: (1) A constant leakage model would require very high fluxes of metagalactic cosmic rays in order to explain the OSO-3 data. (2) It would be more reasonable to consider some evolving source or burst model implying high cosmic ray production in the past when the gas density was greater and interactions were correspondingly more frequent. A present gas density of 10^{-5} cm^{-3} would also allow a more easily acceptable explanation of the OSO-3 data in terms of secondary meson production. M.G.J.

N68-34697*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE SOLAR CONSTANT AND THE SOLAR SPECTRUM MEASURED FROM A RESEARCH AIRCRAFT AT 38,000 FEET

Aug. 1968 69 p refs

(NASA-TM-X-63324; X-322-68-304) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Details are given on the airborne solar irradiance laboratory, the instrumentation features, the flight paths of the Convair 990, the atmospheric correction techniques, and the associated problems common to all the flight experiments. The experimental procedure, data analysis, and results are described for the total irradiance measurements made by the cone radiometer, hy-cal normal incidence pyrheliometer, the Ångstrom pyrheliometer 6618, and the Ångstrom pyrheliometer 7635; and for the spectral irradiance measurements made by the Perkin–Elmer monochromator, the Leiss monochromator, the filter radiometer, the electronic scanning spectrometer, and the P-4 and I-4 interferometers. The values of the solar constant as measured by the four total irradiance instruments are given. Tabulated data are also presented on the values of spectral irradiance of the sun for zero air mass and for the average sun–earth distance. Although the wavelength covered by the measurements is 0.3 to 15μ, the table of values was extended to .14μ in the UV and to 20μ in the IR. M.G.J.

N68-34764# Stanford Univ., Calif. High Energy Physics Lab.

A METHOD TO MEASURE GALACTIC GAMMA-RAYS AND ELECTRONS

E. G. Dally Apr. 1968 7 p refs

(Contract Nonr-225(67))

(HEPL-562; AD-672326)

A knowledge of the galactic gamma-ray and electron flux is of importance in understanding and explaining cosmological phenomena. Until now, few measurements of these fluxes have been conducted. The scope of the measurements made on gamma-rays has been confined to very low or intermediate energies ($I < 1$ GeV). The electron flux has not been measured above a few MeV. Recent detector developments in high energy physics now permit a simple and straightforward search for the shower-producing components (e-, gamma) of the cosmic ray flux. TAB

N68-34774*# Naval Research Lab., Washington, D. C. E. O. Hulburt Center for Space Research.

EXTREME ULTRAVIOLET HELIOGRAMS AND THE SUN'S CORONA

J. D. Purcell, R. Tousey, and M. J. Koomen [1967] 23 p refs Presented at the 10th COSPAR Assembly, London, 24–29 Jul. 1967

(NASA Order R-09-029-036)

(NASA-CR-96785) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Since a large fraction of the spectral lines in the range 171 to 650 Å are coronal and high chromospheric, an extreme ultraviolet (XUV) heliograph was devised to see if emission much higher than 5' above the limb might be detected. The device, which is an XUV spectroheliograph without spectral dispersion, uses an off-axis, normal incidence paraboloidal mirror of 50 cm or 25 cm focal length and Schumann-type SC-7 film. The essential component is a series of aluminum filters with maximum transmittance just longward of the $L_{2,3}$ edge at 171 Å, decreasing gradually to zero at $\lambda > 830$ Å. Detailed data comparisons are presented on the measurements taken at different exposures during the flight experiments and the recordings made by ground based observatories. M.G.J.

N68-34796*# Naval Research Lab., Washington, D. C. E. O. Hulburt Center for Space Research.

EXTREME ULTRAVIOLET HELIOGRAMS AND THE SUN'S CORONA

J. D. Purcell, R. Tousey, and M. J. Koomen Jul. 1967 24 p refs Presented at 10th COSPAR Assembly, London, 24–29 Jul. 1967

(NASA order R-09-029-036)

(NASA-CR-96814) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The XUV heliograph, an XUV spectroheliograph without spectral dispersion, was devised to obtain coverage in the extreme ultraviolet. It has an off-axis normal-incidence paraboloidal mirror three filters in tandem to exclude all visible and near ultraviolet light, and uses Schumann-type SC-7 film. Comparison was made of XUV heliographs with CaK and H-α images taken on the same day. There was an intense coronal emission in the NW from XUV that was not suggested in CaK or H-α. Emission from the plages is much more intense relative to the quiet disk in the XUV than in CaK; and a narrow limb-brightened ring is in the XUV, with maximum intensity in the equatorial regions. This extends over the North Pole, but is absent over the South Pole. One of the explanations for the extended XUV corona is that it is associated with the high coronal abundance of Fe. Results of several flights of the XUV are presented; and white-light coronagraphs, streamers, and other observations are reported. Some comparisons are made with other means of observing the solar corona. M.W.R.

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N68-33641*# Michigan Univ., Ann Arbor. Radio Astronomy Observatory.
MOTION OF A LUMPED-MASS MODEL REPRESENTING A KILOMETER WAVE ORBITING TELESCOPE
Daniel R. Hegg Mar. 1968 184 p refs
(Grant NGR-23-005-131)
(NASA-CR-96630; Rept.-68-6) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Scientific interest in radio astronomical observations at frequencies near 1 MHz have led to the consideration of large earth satellites as radio astronomy observatories. One such concept, a Kilometer Wave Orbiting Telescope (KWOT), consists of a system of four rigid bodies connected to a heavy reference satellite by flexible cables. This report discusses a numerical analysis of the planar motion of a lumped mass model representing the KWOT structure conducted to investigate the feasibility of the KWOT concept. The model consists of a system of particles with interconnecting nonlinear springs and an in place tangential thrust capability. Specifically, the effects of small perturbations from a free space condition of unifrom rotation due to the gravitational gradient and to control thruster activation are investigated. Orbital constraints are assumed, with the reference satellite describing a circular orbit at synchronous altitude. In addition, a coordinated spin up deployment method is studied. Author

N68-33686*# Houston Univ., Tex. Dept. of Chemistry.
ANALYSIS OF ORGANIC MATTER ON THE MOON BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY–A FEASIBILITY STUDY
W. S. Updegrove and J. Oro [1967] 56 p refs Submitted for Publication
(Grant NGR-44-005-043)
(NASA-CR-89481) CSCL 03A

An apparatus which could be used to analyze the organic matter on the moon is described and laboratory results are presented. The instrument consists of two compact mass spectrometers, a quadrupole and a monopole, mounted in parallel on a space simulation chamber which is evacuated to cis lunar pressures with a combination of diffusion, sputter ion, sublimation, and cryogenic pumping. Pulverized or untreated soil samples are introduced through a high temperature vaporizer where the volatile components are forced by hydrogen or helium flow into a capillary gas chromatograph directly connected to the mass spectrometer ion source. No sample enrichment is employed to reduce carrier gas concentration. The two mass spectrometers produce mass spectra simultaneously. The resolution and mass range is such that compounds of mass 300 and greater (500 on the monopole) may be analyzed and identified without difficulty. The application of this gas chromatograph-mass spectrometer system to the analysis of meteoritic and terrestrial samples indicates the feasibility of such a concept not only on the lunar surface but possibly also on other planetary surfaces. Author

N68-33688*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE EXOSPHERIC TEMPERATURE OF VENUS
S. H. Gross, W. E. McGovern, and S. I. Rasool [1967] 8 p refs Presented at the Conf. on Atmospheres of Mars and Venus, Tucson, Ariz., 27 Feb.–2 Mar. 1967 Submitted for Publication
(NASA-TM-X-59785) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The exospheric temperature of Venus has been calculated for several different composition models of the atmosphere. The main purpose of these calculations is to determine whether sufficiently different temperatures would be obtained for the various models, so that the results might provide an estimate of the composition of the lower atmosphere once the exospheric temperature is measured. Author

N68-33753 Indiana Univ., Indianapolis.
ABUNDANCE OF CN IN ALGOL-TYPE ECLIPSING BINARIES
Douglas Scott Hall (Ph.D. Thesis) 1967 144 p
Available from Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-15100

Narrow band photoelectric photometry was used to search for a possible anomalous abundance of CN in the subgiant component of Algol-type binaries by observing systems which undergo total eclipses. The λ 4216 CN band spectrophotometric observations of Griffin and Redman were adopted as a standard system. Three 50 Å half-width interference filters were used to approximate their three wavelength regions which measured the CN absorption strength in terms of a ratio R, defined as $(A+C)/B$ where B is the intensity within the CN band and A and C are intensities in the continuum on either side. Results for 12 Algol-type subgiants suggested that the log of the relative CN abundance has a range of +0.1 to −1.3 and a mean of −0.5. The errors are large due to difficulties encountered in observing such faint stars, the insensitivity of R as an abundance indicator for rather nonluminous stars, and uncertainties in known absolute radii. A consideration of possible systematic errors in the method itself revealed none significant enough to cause the observed systematic apparent underabundance. Dissert. Abstr.

N68-33762*# Florida Univ., Gainesville.
THE SPACE ENVIRONMENT: 100 TO 500 KILOMETERS
Alex E. S. Green Apr. 1967 8 p refs Presented at the Inst. of Environ. Sci. meeting, Washington, D. C., 11 Apr. 1967
(Grant NsG-599)
(NASA-CR-84712) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A summary of theoretical aeronomy studies is presented. Specifically, a semi-quantitative approach to determine the rate of emission of N_2 UV radiation from an IBC 3 aurora is made. Energy loss calculations are approximated for N_2 using an empirical set of excitation and ionization cross sections. Conclusions based on the above calculations included: (1) estimation of relative intensities of N_2 emission; and (2) the existence of more allowed transitions in N_2 than reported. A study of semi-empirical cross section data on important species of N_2, O_2 and O was made, and the Bethe–Born quantum mechanical model of generalized oscillator

strengths was used as an analytic tool for inferring cross section curves from fragmentary experimental data. Energy degradation calculations are applied in determining auroral and airglow line intensities in the IBC 3 aurora. B.P.

N68-33832 Indiana Univ., Bloomington.
A STUDY OF THE EXCITATION MECHANISM FOR CEPHEID PULSATIONS
David Solomon King (Ph.D. Thesis) 1967 137 p
Available from Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-15118

Numerical models of stellar envelopes in the cepheid region of the Hertzsprung–Russell diagram, obtained by solving the fully nonlinear equations of hydrodynamics coupled with radiation flow in the diffusion approximation, have been used to study the excitation mechanism for cepheid pulsations. These models investigate only the excitation due to the second ionization of helium. The zoning is so coarse in the first helium and hydrogen ionization regions that no contribution to the driving can be expected from that portion of the envelope. Pulsation models displaying large amplitude oscillations are used to investigate the physical reason for a limiting amplitude in cepheid type variable stars. The results indicate that a saturation of the excitation mechanism plays a major role in limiting the pulsation amplitude of the model envelopes investigated in this study. Dissert. Abstr.

N68-33865*# Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.
THE CLOUD OF INTERPLANETARY BOULDERS
Martin Harwit Feb. 1967 25 p refs Presented at the Zodiacal Light and the Interplanet. Medium, Honolulu, Feb. 1967 Submitted for Publication
(Contract NSR-33-010-026; Grants NsG-382; NSF GP-1338)
(NASA-CR-83293; CSUAC-70) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The density of boulders (roughly 10m sized objects) in interplanetary space is evaluated. The most plausible density, consistent with various types of data, is $\approx 4 \times 10^{-28}$ cm^{-3}. This is about three orders of magnitude higher than the density usually quoted. The difference arises because it is postulated that the boulders have orbits of low eccentricity; their approach rate toward the earth is slow because the (weak) Poynting-Robertson effect is the only means by which the boulders are impelled into orbits of smaller diameter. The low orbital eccentricity is consistent with an asteroidal orgin of boulders. The unusually high concentration of boulders postulated here can indirectly produce interplanetary dust at a rate high enough to compensate the Poynting-Robertson losses. The high concentration can also explain the observed rate of splitting among parabolic comets, and is consistent with the observation that these comets split near the ecliptic plane. Author

N68-33932# Specola Vaticana (Vatican City).
SPECOLA VATICANA Annual Report
1967 13 p refs
CFSTI: HC $3.00/MF $0.65

Reports of the Vatican astronomical and astrophysical laboratories deal with instrumentation and research activities during 1967. Mention is made of the cataloging of Be stars, image tube spectra of late type standard stars and faint Pleiades stars, spectral classification of LP 101-15, and various other stars and clusters. Polarimetry and photoelectric photometry studies are noted, as is the programming of astronomical computations. A new predisperser of variable dispersion is discussed that is, in principle, a spectroscope of the Czerny-Turner type. Participation of laboratory staffs in international conferences is also reported. M.W.R.

N68-33950 Purdue Univ., Lafayette, Ind.
SINGULARITIES OF THE N-BODY PROBLEM OF CELESTIAL MECHANICS
Donald Gene Saari (Ph.D. Thesis) 1967 35 p
Available from Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-16705

The n-body problem of celestial mechanics is considered from a qualitative viewpoint. The central theme is the question of singularities, both real and complex, in the equations of motion. An inequality relating the minimal distance between particles, r(t), and the radius of convergence at any point t is obtained. Lower bounds on r as it approaches zero can then be determined in terms of the location of the complex singularities. Singularities are also considered by their effect upon the system and vice versa. A sufficient condition as to when a singularity corresponds physically to a collision is obtained. Also, a necessary and sufficient condition for the boundedness of the system at a singularity is found. Relating these results with the previously mentioned inequality yields similar conditions, now in terms of the location of the complex singularities. Dissert. Abstr.

N68-34045*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CONSISTENCY OF LUNAR ORBITER RESIDUALS WITH TRAJECTORY AND LOCAL GRAVITY EFFECTS
Paul M. Muller and William L. Sjogren 1 Sep. 1968 28 p refs
(Contract NAS7-100)
(NASA-CR-98735; JPL-TR-32-1307) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Doppler data from the Lunar Orbiters have yielded residuals larger than normally observed with spacecraft at lunar distance. An analysis of this problem demonstrated a 1:1 correlation between residuals and position on the lunar track and ties the residuals to local lunar gravity effects. The possibility that software was inducing the variations was eliminated by duplicating the residuals with a polynomial fit to the raw data. The results suggest need for a new or modified approach to the lunar potential model that would include one or more of the following characteristics: (1) higher order spherical harmonics; (2) point mass grid solutions; (3) direct mapping of residual-accelerations to the lunar surface. Author

N68-34062# European Space Research Organization, Paris (France).
ESRO BULLETIN NUMBER 4
1967 40 p In FRENCH and ENGLISH
CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ESRO SOUNDING ROCKET ACTIVITY p 4–10 refs (See N68-34063 21-31)
2. AURORAL PARTICLE MEASUREMENTS AT KIRUNA GEOPHYSICAL OBSERVATORY B. Hultqvist (Kiruna Geophys. Obs.) p 17–18 (See N68-34064 21-29)
3. SOLAR AND STELLAR RADIATION INVESTIGATION AT THE SPACE RESEARCH LABORATORY, UTRECHT W. de Graaff (Space Res. Lab.) p 19–21 (See N68-34065 21-29)
4. PROGRESS IN OPERATIONAL PROGRAM p 23–26 (See N68-34066 21-31)

N68-34067*# IIT Research Inst., Chicago, Ill.
ANALYSIS OF CORONAL LINE PROFILES Quarterly Report, 1 Jun.–31 Aug. 1968
Gordon Henderson Aug. 1968 24 p refs
(Contract NASr-65(24))
(NASA-CR-96712; IITRI-V6000-2; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Coronal Fe XIV emission data obtained during the total solar eclipse of 12 November 1966 have been reduced to emission line profiles. The effects of non linearities in wavelength scanning of the Fabry–Perot interferometer and of its instrumental broadening

function were determined in the analysis of the relation between the observed profile and the true emission profile. The data are presented as emission line halfwidths and as temperature assuming pure thermal Doppler broadening for 49 positions out to 1.5 solar radii and for four positions from 1.6 to 2.0 solar radii. Author

N68-34072# European Space Research Organization, Paris (France).
ESRO BULLETIN, NUMBER 3
1967 34 p In FRENCH and ENGLISH
CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ESRO AND THE EUROPEAN SPACE INDUSTRY J. J. Beattie and J. de la Cruz p 3–8 (See N68-34073 21-30)
2. THE ESRO TELEMETRY, TELECOMMAND AND TRACKING NETWORK, PART 2 G. C. Tootill p 9–14 (See N68-34074 21-07)
3. PROGRESS IN OPERATIONAL PROGRAM p 20–22 (See N68-34075 21-31)

N68-34073# European Space Research Organization, Paris (France).
ESRO AND THE EUROPEAN SPACE INDUSTRY
J. J. Beattie and J. de la Cruz *In its* ESRO Bull. No. 3, 1967 p 3–8 (See N68-34072 21-34)

ESRO registers at present 1500 suppliers' names, firms making up what is commonly described as the European space industry. By an equitable distribution of contracts ESRO has been promoting space technology in Europe and its satellite projects like ESRO-1, ESRO-2, HEOS-A, TD-1, TD-2 and the Large Astronomical Satellite have presented industry with a great challenge. ESRO

N68-34078*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SECULAR MOTION OF RESONANT ASTEROIDS
G. E. O. Giacaglia 24 May 1968 78 p refs
(Grant NsG-87-60)
(NASA-CR-96742; SAO Special Rept.-278) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The secular characteristics of the motion of asteroids in resonance with Jupiter are analyzed. The Trojan group is given special attention by a description of these characteristics in a complete qualitative and quantitative manner. Except for collision orbits, the eccentricity and inclination of the asteroid can take any value. The short period perturbations caused by Jupiter are averaged by a nonlinear numerical application of von Zeipel's method. Elimination of the resonant argument is carried, in a semianalytical way, to an approximation of the order of the mass of Jupiter. The final system, with one degree of freedom, is presented by isoenergetic curves in the phase plane (ω, e). The various steps of solution allow a description of the general features of motion for a very long time. Author

N68-34081# European Space Research Organization, Paris (France).
ESRO BULLETIN NUMBER 2
1967 27 p In FRENCH and ENGLISH
CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. THE ESRO TELEMETRY, TELECOMMAND AND TRACKING NETWORK, PART 1 G. C. Tootill p 1–4 (See N68-34082 21-07)
2. THE TD-1, TD-2 SATELLITES p 5–9 (See N68-34083 21-31)
3. SPACE DOCUMENTATION SERVICE J. R. U. Page and N. E. C. Isotta p 10–12 (See N68-34084 21-34)
4. PROGRESS IN OPERATIONAL PROGRAMME p 13–14 (See N68-34085 21-31)

N68-34086*# North American Rockwell Corp., Downey, Calif.
STUDY OF TECHNOLOGY REQUIREMENTS FOR ATMOSPHERE BRAKING TO ORBIT ABOUT MARS AND VENUS. VOLUME 1: SUMMARY, JANUARY–OCTOBER 1967
E. M. Repic Washington NASA Sep. 1968 28 p refs
(Contract NAS-2-4135)
(NASA-CR-1131; SD-67-994-1) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A detailed investigation was conducted to evaluate the advantages and disadvantages of an integrated aerobraking spacecraft. Included were parameter and conceptual design studies to define the spacecraft weights and sensitivity to variations in the environmental models assumed, crew size, mission profile, propellants, etc., as well as internal packaging arrangements. A second objective was to analyze the requirements for system simulation, testing, and qualification. A typical mission profile was developed so that the various operations and systems involved in a Mars landing mission could be viewed in perspective. Figures are drawn to show schematically the mission and an inboard profile of the aerobraker vehicle. Study results showed that (1) the selected aerobraker configurations exhibit satisfactory performance and packaging characteristics and (2) there is considerable commonality between the spacecraft systems required to accomplish the Mars and Venus missions if the parking orbit eccentricity and probe payload parameters are adjusted appropriately. Significant results are discussed in relation to aerobraking vehicle requirements, configuration analysis, sensitivity analysis, and modular approach to vehicle synthesis. B.S.D.

N68-34092*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
STUDY OF PARTICLES COLLECTED BY THE 1966 LUSTER ROCKET (LUSTER 2) Final Report
N. N. Greenman, S. K. Asunmaa, and R. G. Ingersoll Apr. 1968 59 p refs
(Contract NASw-1635)
(NASA-CR-96744; DAC-62220) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Results are presented on a six month investigation of particles collected with the Luster 2 flown during the Orionid meteor shower. The study objectives are listed and the Luster 2 flight and collector are described. Details are given on the heating experiments and electron microprobe analysis. The following are among the conclusions: (1) No evidence of radiation damage annealing was found in any of 43 particles heat-tested. (2) Heating tests on control particles of known materials indicate that significant morphologic change at about 600°C or below or extensive destruction at temperatures of 1000°C or below mark a particle as a probable contaminant, if cosmic dust is assumed to be of meteoritic composition. (3) Of five particles analyzed with the microprobe, two showed compositions consistent with extraterrestrial origin. (4) Silicate particles as small as 0.4 micron can be analyzed with the microprobe. (5) Calculations based on reasonable values of the flux and on the effective collection-time formula show that cosmic dust particles can be collected in adequate numbers by rockets if sampling is begun at a low enough altitude, particularly in the vicinity of the 63-dm opening altitude of Luster 1. B.S.D.

N68-34096# European Space Research Organization, Paris (France).
ESRO BULLETIN NUMBER 1
1967 36 p In FRENCH and ENGLISH
CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. THE ESRO-2 SATELLITE p 2–15 (See N68-34097 21-31)
2. PROGRESS IN OPERATIONAL PROGRAMME p 16–19 (See N68-34098 21-31)

N68-34137*# Techtran Corp., Glen Burnie, Md.
AUTOMATIC DOCKING IN SPACE AND ITS RELATION TO THE THEORY AND PRACTICE OF AUTOMATIC CONTROL [AVTOMATICHESKAYA STYKOVKA V KOSMOSE I YEYE SVYAZ' S TEORIYEY I PRAKTIKOY AVTOMATICHESKOGO UPRAVLENIYA]
V. K. Raushenbakh Washington NASA Sep. 1968 8 p Transl. into ENGLISH of Paper A/Conf.34/V. 10, Presented at the United Nations Conf. on the Exploration and Peaceful Uses of Outer Space, Vienna, 14–27 Aug. 1968
(Contract NASw-1695)
(NASA-TT-F-11939) CFSTI: HC$3.00/MF$0.65 CSCL 22A

Two means of launching larger spacecraft are discussed: bigger boosters or piecemeal launch and construction in space. The latter seems more promising but will require unmanned automatic docking techniques in space. This requires the development of sophisticated automatic control systems. The efficiency of the Soviet rendezvous and docking exercise of October 30, 1967, involving Cosmos 186 and Cosmos 188, is briefly discussed in this connection. Author

N68-34150*# New Mexico State Univ., Las Cruces.
MERCURY'S ROTATION PERIOD: PHOTOGRAPHIC CONFIRMATION
B. A. Smith and F. J. Reese Jul. 1968 12 p refs
(Grants NsG-142-61; NGR-32-003-027)
(NASA-CR-98725; TN-701-69-23) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Photographic measures of surface features on Mercury have led to a rotation period of 58.663 ± 0.021 days, agreeing well with the 58.646-day period required by a predicted 2:3 resonance between the axial and orbital periods. The interpretation of earlier visual and photographic observations which specified the long-held 88-day rotation period appears to be partially explained by peculiar characteristics of the observability of various hermographic longitudes. Additionally, the apparent contrast of most of the recorded surface features is found to be marginal for visual observation when viewed through the terrestrial daytime sky. The intrinsic contrast of a relatively conspicuous feature was measured as 0.20, a value lower than that of typical markings observed on the moon and Mars. Author

N68-34166*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.
HISTORY OF AVIATION AND COSMONAUTICS, VOLUME 5
N. D. Anoshchenko, ed. Washington NASA Aug. 1968 59 p refs Transl. into ENGLISH of the book "Iz Istorii Aviatsii i Kosmonavtiki, Vyp. 5" Moscow, 1967 p 1–64
(Contract NASw-1692)
(NASA-TT-F-11851) CFSTI: HC$3.00/MF$0.65 CSCL 22A

Consideration is given to various advances in the development of aviation and cosmonautics in the Soviet Union. Certain problems which will be encountered with the use of spacecraft are discussed along with the development of Soviet helicopters. The design, flight tests, and final adjustments of the first Soviet helicopter are summarized with attention focused on the design of the lifting rotor and the automatic pitch-control mechanism. Also included is a history of specific contributions of various scientists to the development of Soviet aircraft. B.S.D.

N68-34180*# Martin Co., Denver, Colo.
SUBJECTING SIMULATED LUNAR ROCK SAMPLES TO VACUUM AND THERMAL ENVIRONMENT Final Report
T. C. Shupert Sep. 1968 25 p
(Contract NAS9-8375)
(NASA-CR-92251; MCR-68-365) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The objective of this program was to expose approximately 25 kilograms of simulated lunar rock samples to a vacuum and thermal environment for 30 days in order to remove entrapped gases. The pressure inside the vacuum chamber reached the 10^{-8} torr range and the temperature was maintained at 305°C. for 30 days. This was followed by a decrease of the temperature to 149°C while continuing to pump the vacuum chamber with the ion pumps. The chamber pressure at this time reached 10^{-7} torr. Upon completion of the 30-day exposure the lunar rock samples were transferred to sample containers which were placed in an oven and connected to the vacuum system. The containers were then subjected to the full pumping capacity of the vacuum system for eight hours at 300°C + 25°C. The sample containers with the treated lunar rock samples were hermetically sealed for shipping. Author

N68-34193*# Volt Information Sciences, Inc., Washington, D. C.
ESTIMATE OF THE POSSIBILITY OF CONDUCTING MASS SPECTROMETRIC MEASUREMENTS OF THE MATTER OF LUNAR SURFACE [OTSENKA VOZMOZHNOSTI PROVEDENIYA MASS SPEKTRAL'NOGO ANALIZA VESHCHESTVA LUNNOY POVERKHNOSTI]
V. E. Ivanova and A. N. Pudov 10 Sep. 1968 11 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 4, 1968 p 624–630
(Contract NAS5-12487)
(NASA-CR-98709; ST-ACH-LS-10755) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A method is proposed for determining the chemical composition of the Lunar surface using a radio frequency mass spectrometer. The intake of matter in the analyzer chamber is accomplished by vaporization of lunar rock at electron beam heating. Energy consumption is computed for the case of electron beam interaction with the lunar rock. The efficiency of the vaporization process and the total power required for the vaporization of a sample for the mass spectrometric analysis are determined. The technical requirements imposed on a radio frequency mass spectrometer are represented for the possible use in analyzing the formation of cosmic objects. Author

N68-34207 Liège Univ. (Belgium). Inst. d'Astrophysique.
GRAVITATIONAL INSTABILITY AND FORMATION OF STARS, GALAXIES AND THEIR CHARACTERISTIC STRUCTURES [INSTABILITE GRAVITATIONNELLE ET FORMATION DES ETOILES, DES GALAXIES ET DE LEURS STRUCTURES CARACTERISTIQUES]
1967 324 p refs In FRENCH and ENGLISH Proc. of the 14th Intern. Astrophys. Colloq., Liège, 20–22 Jun. 1966
CFSTI: HC$3.00/MF$0.65

Conference papers on gravitational instabilities are presented, with particular reference made to large structures, galaxy formations, stellar dynamics, star formation, and interstellar matter. For individual titles, see N68-34208 through N68-34231.

N68-34208*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. Lab. for Theoretical Studies.
ON THE ORIGIN OF STRUCTURE IN CERTAIN MODELS OF THE UNIVERSE
E. R. Harrison (NAS–NRC) *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 15–28 refs (See N68-34207 21-30) CSCL 03B

Cosmology is confronted with the problem of explaining how large-scale structures originated in the universe. Within the framework of conventional theory two hypotheses are possible. In the primordial structure hypothesis structural differentiation of a rudimentary form is inlaid within the universe from its earliest moments, whereas in the instability hypothesis structure evolves

naturally from small initial disturbances. It is known that according to linearized gravitational theory, small disturbances in an expanding universe grow extremely slowly. This theory is outlined and furthermore it is shown that large structures are unlikely to form as the result of thermal instabilities. Thus, the instability hypothesis is in serious difficulty and it is proposed that we should re-examine the primordial structure hypothesis. One possibility is that differentiation into structural domains is a natural state of matter at very high densities during the earliest stage of expansion of the universe.
Author (ESRO)

N68-34209# Harvard Coll. Observatory, Cambridge, Mass.
A NOTE ON THE FORMATION OF IRREGULARITIES IN A FRIEDMAN UNIVERSE
William M. Irvine (Smithsonian Astrophys. Obs.) *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 29–32 refs (See N68-34207 21-30)

If general relativistic cosmology is to remain viable, the theory must provide the background for a physically satisfactory description of the formation of astronomical systems. It must be shown that during the early stages of expansion it is reasonable to expect density variations many orders of magnitude greater than those predicted by equilibrium statistical mechanics. It is suggested that quantum effects may lead to pronounced inhomogenities in the early stage of expansion and pointed out that the magnitude of density fluctuations occurring near the epoch of nuclear density depends very strongly on the state of the universe at nuclear or supernuclear densities.
ESRO

N68-34210# Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
THE ROLE OF THERMAL INSTABILITY IN GALAXY FORMATION
M. J. Rees *In* Liège Univ. Gravitational Instablility and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 51-54 refs (See N68-34207 21-30)

It is widely believed that galaxies have developed from instabilities in an almost homogeneous primeval medium. Gravitational instabilities appear to be inadequate to explain this process unless very large initial density fluctuations are postulated. Consideration is given to thermal instabilities to determine whether they are likely to be effective. The conclusion drawn is that they are unlikely to have played a major part in galaxy formation.
ESRO

N68-34211# Texas Univ., Austin. Relativity Center.
PERTURBATIONS OF A COSMOLOGICAL MODEL AND ANGULAR VARIATIONS OF THE MICROWAVE BACKGROUND
R. K. Sachs and A. M. Wolfe *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 59-78 refs (See N68-34207 21-30)

General relativistic, spatially homogeneous and isotropic $k=0$ cosmological models with either pressure zero or pressure 1/3 the energy density are considered. The equations for general linearized perturbations away from these models are explicitly integrated to obtain density fluctuations, rotational perturbations, and gravitational waves. The equations for light rays in the perturbed models are integrated. The models are used to estimate a lower limit on the anisotropy of the microwave radiation, assuming this radiation is cosmological. It is estimated that density fluctuations now of order 10% with characteristic lengths now of order 1000 megaparsecs would cause anisotropies of order 1% in the observed microwave temperature due to the gravitational red shift and other general relativistic effects. The $p=0$ models are compared in detail with corresponding Newtonian models. The perturbed Newtonian models do not contain gravitational waves but the density perturbations and rotational perturbations are surprisingly similar.
Author (ESRO)

N68-34213# London Univ., (England). King's College.
THE STRUCTURE AND STABILITY OF ROTATING MASSIVE STARS IN GENERAL RELATIVITY
Ian W. Roxburgh *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 131–134 refs (See N68-34207 21-30)

The structure equations for a rotating massive star in the general theory of relativity are presented and solved. The dynamical equations are then considered and the fundamental radial mode of oscillation is calculated from a variational principle. This is found to be zero, implying transition from stability to instability when the radius is 208 times the Schwarzchild radius of the star. This implies that stars less than $2\times10^{7}M_{\odot}$ can reach the temperatures required to burn hydrogen and that more massive stars live for some 1.5×10^{4} years before becoming unstable.
Author (ESRO)

N68-34214# Rochester Univ., N. Y. Dept. of Physics and Astronomy.
SOME INSTABILITIES OF NON-CIRCULAR MOTIONS IN THE GALAXY
H. L. Helfer *In* Liege Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 151–154 refs Supported in part by Guggenheim Mem. Found. (See N68-34207 21-30)

In certain cases, the evolution of a velocity perturbation of a gas in the galactic disc may be more influenced by the non-linear terms in the hydrodynamic equations than by the attendant perturbation terms due to the pressure and self-gravitational force. The effect of the non-linear terms is investigated analytically and it appears as if there will develop spiral arm-like loci characterized by density increases and large values of the derivatives of the velocity perturbation.
Author (ESRO)

N68-34215# Liège Univ. (Belgium). Inst. d'Astrophysique.
GRAVITATIONAL INSTABILITY IN ISOTHERMAL NEBULA [INSTABILITE GRAVITATIONNELLE DANS LA NEBULEUSE ISOTHERME]
R. Simon *In its* Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 155-165 refs In FRENCH; ENGLISH summary (See N68-34207 21-30)

Linear and adiabatic ($\gamma=5/3$), or isothermal ($\gamma=1$), perturbations in the stratified isothermal nebula in uniform rotation are governed by a 4th order set of differential equations. This set possesses continuous and discrete spectra in the σ^2, k plane, where k is the wave number and σ the frequency of a typical normal mode of oscillation. The continuous spectra can be derived by the analytical discussion of the singularity of the problem. On the other hand, the discrete spectra can be obtained by numerical integration. Such an integration has been performed for different values of the angular velocity of rotation Ω. It shows that above a certain critical value Ω_c which slightly depends on γ, the rotation completely inhibits the phenomenon of gravitational instability.
Author (ESRO)

N68-34218# Imperial Coll. of Science and Technology, London (England).
A UNIFIED THEORY FOR SPIRAL AND RADIO GALAXIES
Howard D. Greyber *In* Liege Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 189–195 refs (See N68-34207 21-30)

The relevance of a galactic dipole magnetic field model (GDMFM) to problems of galaxies such as the persistance of spiral structure, the magnetic field configuration in spiral arms, and the circulation of interstellar matter has been previously emphasized. More evidence for this unified theory point of view is given and a plausible mechanism for generating a galactic dipole magnetic field and its associated gravitational bound current loop in astrophysical objects described supplies cosmology with a boundary condition, or requirement, for large-scale turbulence on the isolated pregalactic gas cloud. It is shown that only large-scale turbulence will survive the decay process of the expansion of the universe.
ESRO

N68-34219# Imperial Coll. of Science and Technology, London (England).
MAGNETIC FIELD CONFIGURATION IN GALACTIC SPIRAL ARMS
Howard D. Greyber *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 197-201 refs (See N68-34207 21-30)

Observational and theoretical evidence is adduced for a magnetic field configuration that has magnetic lines of force running in one direction along the arm above the plane of the galaxy and in the opposite direction below the plane. The model permits the resolution of a basic problem in the theory of star formation. Author (ESRO)

N68-34220# Thessaloniki Univ. (Greece).
STELLAR ORBITS AND THE STABILITY OF SPIRAL STRUCTURE
G. Contopoulos *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 213-225 refs (See N68-34207 21-30)

The problem of the formation and stability of spiral structure in a disc galaxy composed mainly of stars has drawn much interest in recent years. It is proved that in the case of a spiral field of rather general form, which rotates as a rigid body, one can find two integrals of motion, corresponding to the Jacobi integral and to the third integral, which can be used in the arguments in the distribution function. If an imposed field is applied over a gravitating field the time variation of the field and the corresponding changes of the density and the distribution function can be found step by step. Some conclusions on the stability of the spiral arm can be drawn in this way. ESRO

N68-34222# Institut d'Astrophysique, Paris (France).
INITIAL COLLAPSE AND DYNAMICAL MIXING OF A SPHERICAL CLUSTER
M. Hénon *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 243-248 refs (See N68-34207 21-30)

It is assumed that a star cluster is formed from a gas cloud, after the stars are formed, assuming spherical symmetry. The behavior of the system that fragments into stars is analyzed. It is shown that the initial collapse is followed by expansion but that these oscillations are strongly damped, leading to a steady state which depends on initial conditions. Author (ESRO)

N68-34221# Smithsonian Astrophysical Observatory, Cambridge, Mass.
THE VALIDITY OF THE VLASOV EQUATION FOR A ONE-DIMENSIONAL SELF-GRAVITATING GAS
Myron Lecar *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 227-236 refs (See N68-34207 21-30)

The magnitude of the two-body relaxation term in the Boltzmann equation for a one-dimensional self-gravitating gas has been estimated from numerical experiments. Systems containing N = 50, 100 bodies have been integrated for N dynamical periods. There was no secular increase in the entropy, and only a slight tendency toward a central concentration of the more massive particles, supporting the theoretical prediction that the two-body relaxation time is approximately N dynamical periods. Author (ESRO)

N68-34223# Institut d'Astrophysique, Paris (France).
GRAVITATIONAL INSTABILITY OF INTERSTELLAR MEDIUM AND STAR FORMATION [INSTABILITE GRAVITATIONNELLE DANS LA MATIERE INTERSTELLAIRE ET FORMATION DES ETOILES]
E. Schatzman *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 265-277 refs (See N68-34207 21-30)

This report represents a state of present knowledge on galactic medium and star formation. The characteristics of galactic medium are given and mass and energy balance of star formation are computed. The problem of gravitational instability is dealt with and a statistical model for the formation of plasma clouds is designed. Their equilibrium and collapsing conditions are analyzed. The problem of the formation of protostars is mentioned. ESRO

N68-34224# London Univ. (England). Observatory.
PROPERTIES OF THE INTERSTELLAR MEDIUM
D. Mc Nally *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 279-281 refs (See N68-34207 21-30)

The properties of the interstellar gas are outlined in so far as these are known. Some problems connected with these properties are discussed. Author (ESRO)

N68-34225# Manchester Univ. (England).
CONDENSATIONS IN THE ORION NEBULA
J. E. Dyson *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 291-296 refs (See N68-34207 21-30)

Hydrodynamic estimates of the age of the Orion nebula give a time scale of 104 years since the nebula was formed but this is difficult to reconcile with the estimated age of the associated star cluster. Since the time scale derives from the root-mean-square it must be assumed that the center of the nebula has a greater density. A condensation model is designed assuming the presence of neutral gas surrounded by ionized gas. ESRO

N68-34226# London Univ. (England). Observatory.
NUMERICAL METHODS IN GRAVITATIONAL COLLAPSE PROBLEMS
D. Mc Nally *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 301-303 refs (See N68-34207 21-30)

The methods of numerical solution of the equation of hydrodynamics with gravitation and the results of such solution for model interstellar gas clouds are briefly discussed. Author (ESRO)

N68-34227# Yale Univ. Observatory, New Haven, Conn.
NUMERICAL STUDIES RELATING TO STAR FORMATION
James A. Hunter, Jr. *In* Liege Univ. Gravitational Instability and Formation of Stars, Galaxies and their Characteristic Struct. 1967 p 307-313 refs (See N68-34207 21-30)

An improved numerical code for integrating spherically symmetric gas dynamical problems has been developed with the help of Jeans theory and applied to gravitational collapse. A computer code has been developed to study thermal and gravitational effects in spherical clouds. ESRO

N68-34228# Ghent Univ. (Belgium). Inst. of Physics.
JEANS'S CRITERION AND THE DIMENSIONS OF STARS AND GALAXIES
D. K. Callebaut (Interuniv. Inst. for Nucl. Sci., Belgium) *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 319-324 refs (See N68-34207 21-30)

It is shown that Jeans's criterion determines a relation between the stellar mass and β, the ratio of gas pressure to total pressure. For β_c this yields an upper limit for the stellar mass, supplementing Chandrasekhar's lower limit and thus strengthening his relation expressing the average stellar mass in function of the fundamental constants. Moreover, the ratio of the average stellar mass to the proton mass may be expressed by the ratio of the Coulomb potential to the gravitational potential of two protons. The same idea is applied to galaxies and yields a fair estimate for their masses. The interpretation is free from the objection that gravitational instability may be too slow to form a galaxy out of a uniform and infinite medium. Author (ESRO)

N68-34229# Harvard Coll. Observatory, Cambridge, Mass.
ON THE STABILITY OF A COLLAPSING GAS CLOUD AGAINST FRAGMENTATION
David Layzer *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 325-328 refs (See N68-34207 21-30)

A collapsing spherical cloud of uniform mean density is unstable against the growth of local density fluctuations. The initial development of density and velocity fluctuations is described by first-order perturbation theory. The subsequent development is dominated by nonlinear effects and is accordingly not amenable to rigorous theoretical analysis. A number of semi-quantitative arguments are available, however, bearing on particular aspects of the problem. These arguments are mutually consistent and point to the conclusion that the growth of local fluctuations gives rise to turbulence. Thus the assumption that the growth of local density fluctuations causes an initial separation of the cloud into distinct fragments leads to the conclusion that this condition is highly transitory: the fragments would either be reabsorbed into the cloud or would disintegrate. If the alternative assumption is made that the growth of local density fluctuations gives rise to turbulence, it is found that the tendency of overdense eddies to contract faster than the cloud as a whole is not strong enough to affect their transitory character. Author (ESRO)

N68-34230# London Univ. (England). King's College.
EFFECT OF ROTATION AND MAGNETIC FIELDS ON THE FORMATION OF SINGLE AND MULTIPLE STARS
Ian W. Roxburgh *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 343-350 refs (See N68-34207 21-30)

The pre-main sequence contraction of spherical stars is briefly discussed. This stage of evolution is then re-examined including the effect of rotation and it is shown that during the growth of a radiative core the angular velocity increases in the central regions of a star until the star becomes unstable. Assuming that the star then splits to form a binary system, it is shown that the predicted properties of close binaries is in good agreement with the observed properties. If the star has a magnetic field which survives the Hayashi phase, then it is shown that this will prevent the formation of binary stars provided the field is greater than 1 gauss. Author (ESRO)

N68-34231# Cambridge Univ. (England).
ON THE FORMATION OF CLOSE BINARY SYSTEMS
L. Mestel *In* Liège Univ. Gravitational Instability and Formation of Stars, Galaxies and Their Characteristic Struct. 1967 p 351-358 refs (See N68-34231 21-30)

The formation of close binary systems is envisaged. It is known that when a system of protostars disintegrates and an element escapes the dynamical evolution will lead to a binary system which will form a wide binary if the components contract without any marked decrease in their mutual orbital angular momentum. This decrease will be due to magnetic braking bringing the two stars close together. The system is studied with attention to mass-loss rather than to quasi-steady stellar wind. The theory of magnetic braking of single stars is analyzed, and applied to a binary system. The time for the system to contract is computed. Author (ESRO)

N68-34264*# Maryland Univ., College Park. The Inst. for Fluid Dynamics and Applied Mathematics.
INSTABILITY OF THE EKMAN SPIRAL WITH APPLICATIONS TO THE PLANETARY BOUNDARY LAYERS
Alan J. Faller and Robert Kaylor Nov. 1966 41 p refs Presented at the IUGG-IUTAM Symp. on Boundary Layers and Turbulence Including Geophys. App., Kyoto, 19–24 Sep. 1966
(Grants NsG-398; NSF GP-3443)
(NASA-CR-86714; BN-482) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The Ekman spiral boundary layer is a simple example of secondary flows where the velocity vector changes direction with distance from the boundary. The ideal Ekman spiral occurs in rotating systems near boundary surfaces perpendicular to the rotation axis when the flow is slow compared to the speed of rotation. Previous experimental and theoretical results on the shear-flow instability for a rigid boundary are briefly reviewed. New results are presented for the Ekman layer with a free boundary and for shear-flow instability in the presence of density stratification. The principal new results, obtained by means of numerical integrations of the equations of motion, are: (1) For the Ekman boundary layer caused by wind stress on a free water surface the critical Reynolds number is much less than for the case of flow over a smooth rigid boundary. (2) For the free-surface case the distortion of the basic boundary-layer flow by the finite-amplitude roll vortices is very great. (3) With unstable density stratification either shear-flow instability or thermal convection may dominate. (4) With stable density stratification the shear-flow instability may be resonant with internal gravity-wave oscillations. Some of the implications of these results for the planetary boundary layers of the atmosphere and ocean are considered. Author

N68-34266# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
OAO EXPERIMENT SUCCESS AS A FUNCTION OF OBSERVING TIME
S. N. Milford and L. L. Smith Aug. 1968 27 p refs
(RE-337)

Four OAO experiments are examined—University of Wisconsin (WEP), Smithsonian Astrophysical Observatory (SAO-Project Celescope), Goddard Space Flight Center (GEP), and Princeton University (PEP). The criteria for complete success (100%) have been set to correspond to an OAO lifetime of one year. The lowest success level (25%) is set by the need to duplicate the observations from rocket flights. To achieve 25% experiment success, the spacecraft must operate for a period of 1 to 2 weeks depending on which experiment package is considered; 50% success takes 2 to 4 weeks; 90% takes 4 to 15 weeks; 100% takes one year, the longest time interval during which one can reasonably expect to receive useful signals from the spacecraft. Author

N68-34268# Adelaide Univ. (Australia). Dept. of Physics.
A NOVA MODEL OF CENTAURUS XR-2
P. J. Edwards [1967] 8 p refs Submitted for publication
CFSTI: HC $3.00/MF $0.65

Results of recent observations of the Centaurus region have suggested a model of explosive expansion, the X-radiation orginating in a shell of shock heated gas. ESRO

N68-34288*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CHANGES IN THE LOWER EXOSPHERE SINCE SOLAR MINIMUM
Gerald M. Keating May 1968 25 p refs Presented at the 9th COSPAR Intern. Space Sci. Symp., Tokyo, 8–21 May 1968
(NASA-TM-X-61239) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Measurements of atmospheric densities between 500 km and 750 km and between ±80° latitude have been made by means of the Explorer XIX (1963-53A) and Explorer XXIV (1964-78A) satellites during the period of increasing solar activity (1964–1967). During this period the atmosphere has expanded due to increased solar heating to such an extent that near 700 km recent measurements indicate densities 30 times greater than were measured at minimum solar activity. Latitudinal-seasonal variations have changed during this period of increased solar heating. It was found that peak densities near 650 km have shifted from high latitudes in the winter hemisphere to low latitudes in the summer hemisphere. This change in latitudinal-seasonal variations confirms the prediction of Keating and Prior that at these altitudes with an increase in solar activity, the winter helium bulge would be dwarfed

by an expanding summer atomic oxygen bulge. It is apparent that atomic oxygen has now replaced helium as the principal constituent near 650 km. Author

N68-34307*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ON THE THERMAL RADIOEMISSION OF MERCURY
Yu. N. Vetukhnovskaya and A. D. Kuzmin Redstone Arsenal, Ala. Redstone Sci. Inform. Center 27 Jun. 1968 21 p refs Transl. into ENGLISH from the Russian preprint 153 (Moscow), 1967
(NASA-TM-X-61185; RSIC-818) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Analysis of the physical conditions of the planet Mercury through radio astronomical measurements of the luminance temperature indicates the possibility of successfully investigating the temperature regime of Mercury and the thermal and electrical properties of its surface material. Significant information about the thermal properties of the planet's surface may be obtained from measurements of the luminance temperatures of the night side of the planet in the IR portion of the spectrum. In order to interpret the results of the measurements it is necessary to establish the relation between the measured quantities and the physical properties of the surface material. Discussed in this paper is the thermal regime and the radioemission of Mercury. A comparison is made between theory and experiment. Author

N68-34318*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE SURVEYOR 1 AND SURVEYOR 2 FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
T. H. Thornton, Jr., R. G. Labrum, W. R. Wollenhaupt, S. K. Wong, C. M. Meredith (Hughes Aircraft Co., Culver City, Calif.) et al 1 Aug. 1968 125 p refs
(Contract NAS7-100)
(NASA-CR-96719; JPL-TR-32-1285) CFSTI: HC $3.00/MF $0.65 CSCL 22C

This report describes the current best estimate of the *Surveyor I* and *Surveyor II* flight paths and the way in which they were determined. The function and organization of the flight path analysis and command (FPAC) group—within which the flight path and the midcourse and terminal-descent maneuvers were determined in real time—are described. Detailed accounts are given for each phase of the flights. Data summaries and analyses include: the orbit determination process and the best estimates of the pre-midcourse correction orbit and the post-midcourse correction orbit; the postflight analysis of the transponder tracking data to give the final best estimates of the pre- and postmaneuver orbits, as well as the estimated values for station locations and certain physical constants; the philosophy used for determining the midcourse correction and the terminal maneuver; pertinent trajectory characteristics; and the inflight and postflight analysis of the Air Force Eastern Test Range tracking data. Author

N68-34323*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EARTH ORBITAL PROGRAM STRATEGY
William N. Gardner and W. Ray Hook May 1968 17 p Presented at the SAE Space Technol. Conf., Washington, D. C., 8–10 May 1968
(NASA-TM-X-61213) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The objectives of NASA earth orbital programs are: to develop space systems that will contribute to the solution of basic national problems by exploiting space for human welfare and knowledge, to exploit space for the advancement of science and technology, and to develop space capabilities precursory to planetary exploration. The role of a space station in the earth orbital program is that of a manned orbital research facility capable of exploiting the unique features of the space environment in combination with the capabilities of man as an onboard investigator to accomplish a broad spectrum of research and development in all areas of interest. A manned orbiting research facility, however, should not be utilized to perform functions or programs which can be done economically and reliably by automated spacecraft. Author

N68-34356# National Physical Lab., New Delhi, (India). Radio Propagation Unit.
SPACE RESEARCH IN INDIA
A. P. Mitra 15 Mar. 1968 44 p refs
(RPU-S41; SR-41) CFSTI: HC $3.00/MF $0.65

Current space research activities in India are described. Discussion covers satellite and rocket studies. Activities on the practical applications of space research are also indicated. Author

N68-34390*# Stanford Research Inst., Menlo Park, Calif.
SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 3: ASTRONOMY AS AN EXAMPLE OF SCIENTIFIC IMPACTS
I. M. Levitt Jun. 1968 60 p refs
(Contract NASw-1722; SRI Proj. MU-7227)
(NASA-CR-96812) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The discipline of astronomy is used as an example to describe the great impact of space exploration on science and the relation of scientific findings to human culture. A general discussion on astronomy and space is followed by detailed discussions on astrometry, spectroscopy, photometry, radio astronomy, the sun and planets, X-ray and gamma ray astronomy, interstellar physics and galactic studies, and cosmology. Past and future achievements are related to man's culture; with attention given to earth-based experimentation of the past, the expectations from future terrestrial observations, and possibilities of information from orbiting observatories. M.W.R.

N68-34426*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PERTURBATION ANALYSIS OF EXISTING RESONANT SATELLITES
Bruce C. Douglas (Wolf Res. and Devel. Corp., College Pk., Md.) and Carl A. Wagner Aug. 1968 67 p ref
(NASA-TM-X-63328; X-643-68-338) CFSTI: HC $3.00/MF $0.65 CSCL 22C

This document presents a detailed analysis of the resonant perturbations to the 20th degree and order on 83 existing satellites. This analysis reveals that terms of order (m) 2 and 12–14 are well represented by existing resonant satellites. Only a few resonances for the other orders are available. The study also shows that for resonant orbits with beat periods less than about 15 days, the frequencies contributed by the terms resonant with an orbit are all nearly the same, making such orbits of limited value for geodesy if considered individually. This situation is aggravated for orbits at or near the critical inclination. The phenomenon of shallow resonance has also been studied. The results of this study show that to accurately analyze resonant orbits, considerable attention to calculation of mean mean motion is necessary. Highly accurate formulae to calculate mean mean motion have been derived and are presented. Author

N68-34444*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
RECENT RESULTS FROM LUNAR EXPLORER 35
Norman F. Ness Sep. 1968 28 p refs Presented at Conf. on the Physics of the Moon and Planets, Kiev, USSR, 1968
(NASA-TM-X-63327; X-616-68-335) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Measurements since July 1967 from lunar orbit by Explorer 35 have provided significant data on the moon and its environment. When the moon is imbedded in the geomagnetic tail, no intrinsic lunar magnetic field is detected, limiting its magnetic moment to 10^{20} cgs units, less than 10^{-6} of the earth's. This corresponds to an intrinsic lunar field of less than 40 μ Gauss on the lunar surface. The magnetic susceptibility of the moon is less than 1.8 μ_0 if the interior is below the Curie point. In interplanetary space

no evidence is found for a bow shock wave due to the flow of the supersonic solar wind plasma past the moon. A solar plasma shadow or cavity evolves on the nightside of the moon as the moon absorbs the plasma with small perturbations of the magnitude and direction of the interplanetary magnetic field. The imbedded interplanetary magnetic field appears to diffuse as rapidly through the interior of the moon as the solar wind convectively transports it past the moon. Author

N68-34492*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NUCLEATION AND GRAIN GROWTH IN INTERSTELLAR SPACE
Bertram Donn [1967] 27 p refs Submitted for publication
(NASA-TM-X-59720) CFSTI: $3.00 CSCL 03B

Various studies are summarized in which the origin of interstellar grains are investigated with emphasis on the nucleation and subsequent growth in interstellar space. The nucleation theory is discussed, and equations are given which show the fundamental role of supersaturation ratio of all elements of interest in interstellar medium. Tabulated data are included on concentrations, partial pressures at 100°K and impact frequencies per cm^2 for the more abundant elements and observed radicals. Using carbon, the kinetics of formation of pure grains are examined. Brief consideration is given to graphite formation in cool carbon stars and the role of chemical reactions in forming interstellar grains. B.S.D.

N68-34501*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PLANETARY ATMOSPHERE MASS SPECTROMETRY
N. W. Spencer Sep. 1968 27 p refs Presented at the Am. Astronautical Soc. Meeting on Advan. Space Expt., Ann Arbor, Mich., Sep. 1968
(NASA-TM-X-63332; X-620-68-350) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The present capability for Earth atmosphere composition determination by mass spectrometry makes possible in situ qualitative and quantitative measurements of the constituents of the atmospheres of the two nearest planets, Mars and Venus. Ion spectrometer systems can be used in planetary atmospheres studies to resolve pressing questions regarding the nature of the ions in those atmospheres. Advanced digital techniques now permit low data-rate systems which search the full mass range, then measure and record only those masses that exceed the in situ-determined noise level by a fixed amount. Thus the systems make very efficient use of data systems, adapting instrument operation to the composition of the atmosphere. Systems appropriate to Mars and Venus are not being prepared for flight tests. The instruments weigh about 10 pounds, require about 10 watts and are sterilizable. Author

N68-34508*# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.
IMPROVEMENT OF THE SPHEROIDAL METHOD FOR ARTIFICIAL SATELLITES
John P. Vinti Jul. 1968 29 p refs
(Grant NGR-22-009-262)
(NASA-CR-96714; RE-47) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Objections to applying the spheroidal method to calculate a polar orbit of an artificial satellite are easily overcome. Previous papers have already treated the behavior in an exactly polar orbit of the right ascension ϕ, the coordinate for which the difficulty supposedly occurs. Just as in the Keplerian problem, it remains constant, except for jumps of 180° at a pole. There remains the case of an almost polar orbit, for which the calculation of ϕ may be inaccurate near a pole, unless one takes special precautions. The present paper first simplifies the expression for ϕ for all orbits, polar or not, and then shows how to avoid the difficulty altogether, by solving directly for rectangular coordinates and velocities. The present paper simplifies orbital calculations by the spheroidal method for satellite orbits with all inclinations. Its main points are the bypassing of the right ascension and the avoidance of differences of almost equal quantities, so that all calculations become well conditioned. Author

N68-34551*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE DRY MASSIVE MODEL OF THE ATMOSPHERE OF VENUS AND THE MICROWAVE PHASE EFFECT
Patrick Thaddeus [1967] 7 p refs Presented at the Conf. on Atmospheres of Mars and Venus, Tucson, Ariz., 27 Feb.–2 Mar. 1967 Submitted for publication
(NASA-TM-X-59737) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A theory is proposed for calculating the temperature profiles in the thermal and convective boundary layers of Venus. The assumptions are made: (1) Due to the large atmospheric heat capacity and small Coriolis force, even a gentle general circulation is effective in maintaining a temperature profile above the boundary layer which is independent of latitude or longitude. (2) The entire burden of explaining the microwave phase effect falls on the boundary layer. It is also assumed that the polar axis on Venus is perpendicular to the orbital plane. It is hypothesized that the thickness of the boundary layer on Venus is comparable to that on earth and is, in any case, less than 1 meter. The point is made that if the lower scale height has a mean infrared opacity of the order of 10^2 due to the resonant and induced transitions of CO_2 and N_2, then the boundary layer is still optically thin in the infrared. M.G.J.

N68-34593# Aerospace Corp., El Segundo, Calif. Lab. Operations.
SPACE PHYSICS LABORATORY'S SUMMARY OF SPACE RESEARCH SUBMITTED TO COSPAR CY 1967 Technical Report, Jan.–Dec. 1967
R. A. Becker Jun. 1968 68 p refs
(Contract F04695-67-C-0158)
(TR-0158(9990)-5; SAMSO-TR-68-236; AD-672246)

Preliminary results are presented from the experiments on the Air Force Satellites 1966-70A and 1966-111B and NASA Satellite 1966-110A. Highlights of the particle measurements were the solar flare particle spectra and the evidence for the penetration of these particles into the magnetosphere. The optical measurements on 1966-111B included worldwide observations of atmospheric nightglow at 3914 A, 5577 A, 5735 A, and 6300 A, atmospheric day radiance between 1600 A and 3200 A, Lyman-alpha radiation scattered from the enosphere, and extensive measurements of solar soft X rays in the approximate range from 1 to 13 A, with proportional counters, and in the range from 7 to 25 A, with a Bragg crystal spectrometer. Several results are also presented from the program in laboratory aeronomy. Finally, a progress report from the ground-based solar program is presented. Author (TAB)

N68-34673*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
THE STRUCTURE OF THE MARTIAN ATMOSPHERE
Joseph S. Hogan [1968] 194 p refs Prepared in cooperation with New York Univ.
(NASA-TM-X-61178) CFSTI: $3.00 CSCL 03B

Data from the Mariner IV occulation experiment are analyzed in order to find the structure of the neutral atmosphere and ionosphere on Mars. Required input data are chosen from recent estimates of surface parameters and atmospheric composition under inclusion of possible effects of CO_2 photochemistry, turbulent mixing, and molecular diffusion on the gas distribution. Upper and lower limits for the neutral particle number density in the observed ionosphere are derived and an ionospheric model is proposed. Results indicate cooler Mars temperatures than originally estimated; neutral particle number density in the observed ionosphere is between 10^{10} mol/cm^3 and 10^{11} mol/cm^3. It is concluded that the Martian ionosphere observed by Mariner IV is of the F1 type. This ionospheric model allows for the development of a true

thermospheric structure with a positive temperature gradient in the upper Martian atmosphere. G.G.

N68-34675*# National Aeronautics and Space Administration, Washington, D. C.
NASA'S FIRST TEN YEARS Tenth Anniversary Special
1 Oct. 1968 12 p
(NASA-TM-X-61181) CFSTI: HC$3.00/MF$0.65 CSCL 22A

The United States Space Agency reviews research activities during its first 10 years of existence and the new technology and knowledge growing out of aeronautical, nuclear, and space studies. Discussed are: (1) general release; (2) aeronautics first "A" in NASA; (3) advanced research: Freedom of choice; (4) unmanned satellites; (5) manned flight; (6) tracking and data acquisition; (7) international cooperation; (8) technology utilization; and (9) launch vehicles. Miscellaneous items included cover the 1958 space act, a budget history, an organizational chart, all major milestones, a major launch record, the astronaut status, fillers, and NASA installations. G.G.

N68-34690*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
AN X-RAY TEST FOR SUPERDENSE STARS
Elihu Boldt Sep. 1968 5 p refs
(NASA-TM-X-63331; X-611-68-348) CFSTI: HC $3.00/MF $0.65 CSCL 03B

As strong thermal X-ray emission from a small source ($\approx 10^6$ cm) is a signature to be expected from a superdense star, it is pointed out that the superdense star hypothesis for a thermal X-ray source may be tested by measuring the statistical fluctuations in the observed X-ray photon count. As an example, this is shown to be a practical test for the X-ray star Sco X-1. Author

N68-34696*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
THE PRINCIPLE OF PLANETARY UNIPOLAR GENERATORS
C. P. Sonett [1968] 9 p refs Presented at the 4th Intern. Conf. on the Universal Aspects of Atmospheric Elec., Tokyo, 12–18 May 1968
(NASA-TM-X-61236) CFSTI: HC$3.00/MF$0.65 CSCL 03B

A model is presented which permits the calculation of the current magnitude and establishes the properties of the planet as a unipolar electrical generator. It is pointed out that the establishment of the unipolar magnetic field means that a back pressure will develop which tends to retard the action of the solar wind in forcing the field into the planet; thus, the net electric field which is generated is reduced, and the mechanism tends to saturation. For a homogeneous planet at the distance of the moon from the sun and for the present epoch solar wind, it is shown that the current in the lowest mode cannot become greater than several times 10^5 amperes. M.G.J.

N68-34710*# Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science.
SOME RECENT RESULTS OF X-RAY ASTRONOMY
B. B. Rossi Feb. 1967 32 p refs Submitted for publication
(Grant NsG-386)
(NASA-CR-89759) CFSTI: HC$3.00/MF$0.65 CSCL 03A

An experiment and the subsequent analyses for positively identifying and positioning the Sco X-1 strong X-ray source are discussed in detail. Emphasis is placed on determining the angular size and the angular coordinates of Sco X-1. A rocket flight was conducted in which improvements were made in the angular resolution of the X-ray detector, and the accuracy in the determination of its instantaneous orientation with respect to the stars. The position of the object as measured at both Tokyo and the Palomar observatories was: right ascension, $16^h\ 17^m\ 4.3^s$ and declination, $-15°\ 31'\ 13''$. A table of tentative properties of Sco X-1 is included. C.T.C.

N68-34727*# National Aeronautics and Space Administration, Goddard Inst. for Space Studies, New York.
EVOLUTION OF THE EARTH'S ATMOSPHERE
S. I. Rasool [1967] 10 p refs Submitted for publication
(NASA-TM-X-61176) CFSTI: HC$3.00/MF$0.65 CSCL 03B

A comparison of the earth's atmospheric composition with other planetary atmospheres establishes a wide variety and it is concluded that important evolutionary changes have taken place over a period of about 4.5 billion years. A deficiency of certain elements in the earth's atmosphere indicates that the earth lost all elements which could have been gaseous at temperatures of a few hundred degrees during the very early history of the planet. Biochemical arguments and geological evidence suggest that the present atmosphere and hydrosphere arose largely from the interior via volcanic emanations. Theories and calculations on the H_2O photochemistry indicate that free oxygen was limited to $\approx 0.1\%$ of the present atmospheric level during the entire pre-biological history and then accumulated slowly to the present amount after the start of photosynthesis about 800 million years ago. G.G.

N68-34753*# Naval Research Lab., Washington, D. C. E. O. Hulbert Center for Space Research.
THE LUNAR CRESCENT AND EARTHSHINE OBSERVED AT 2° SOLAR ELONGATION
M. J. Koomen, R. Tousey, and R. T. Seal, Jr. [1967] 22 p refs Presented at the 10th COSPAR Assembly, London, 24–29 Jul. 1967 Submitted for publication
(NASA Order R-09-029-036)
(NASA-CR-96784) CFSTI: HC$3.00/MF$0.65 CSCL 03A

Consideration is given to photographs made from an Aerobee-150 rocket, with externally occulted Lyot coronagraphs which show the earthlit moon at elongation of only 2°. The objectives were (1) to look for the new moon's new crescent, and (2) to detect dust between the moon and the earth that might contribute to the brightness of the F-corona. An analysis of the photographs show that there is a negligible amount of light-scattering material between the moon and earth. The trace of the new moon crescent was present as an irregular glint near Mare Marginis. It is concluded that the glint is probably produced by the floor of Mare Marginis which must be free of tilts greater than 2°. B.S.D.

N68-34762*# Naval Research Lab., Washington, D. C. Center for Space Research.
ON SOME ASPECTS OF XUV SPECTROHELIOGRAMS
R. Tousey, G. D. Sandlin, and J. D. Purcell Oct. 1967 19 p refs Presented at the Intern. Astron. Union Meeting Symp. No. 35: The Struct. and Develop. of Solar Active Reg., Budapest, Oct. 1967
(NASA Order R-09-029-036)
(NASA-CR-96816) CFSTI: HC$3.00/MF$0.65 CSCL 03A

Tabulated data are presented on the dates on which extreme ultraviolet (XUV) spectroheliograms and heliograms were obtained, and the solar activity and the nature of the photographic results. For making intensity correlations between the XUV and Ca--K plages, an arbitrary intensity scale was devised. Plages were selected no farther than approximately 70° from the central longitude. The photographic density of each active region in He II 304 Å was estimated relative to the average disk background on a scale rated: 1 = just detectable, to 5 = extremely bright. This was also done for the XUV heliograms. Generally, when the He II 304 Å intensity values were plotted against the values for the same regions in Ca--K, a linear relationship was observed with a scatter of ± half a scale unit. Exceptions to these findings are discussed in detail. It was also found that the intensity estimates of the plages, as recorded by the broadband XUV heliograph correlated well with Ca--K. The plages in He II 304 Å are more intense relative to the quiet background than in Ca--K, as was found for H-Lyman-α. Author

N68-34769*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FULL-SCALE SIMULATION OF PARACHUTE DEPLOYMENT ENVIRONMENT IN THE ATMOSPHERE OF MARS

Clarence L. Gills and Richard J. Bendura [1968] 7 p refs Presented at the 14th Ann. Tech. Meeting of the Inst. of Environ. Sci., St. Louis, 29 Apr.–1 May 1968

(NASA-TM-X-61217) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A flight-test program was conducted to investigate the operating characteristics of large-size parachutes in an environment simulating that expected during a Mars landing mission. The choice of simulation parameters is discussed and the effects on the results of those quantities not simulated are considered. The environmental factors of major importance to the performance of the parachutes appear to have been adequately represented in the tests. Author

N68-34772*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A METHOD FOR CONTROLLING PARACHUTE DEPLOYMENT CONDITIONS IN SIMULATED PLANETARY ENVIRONMENTS

John S. Preisser and Harold N. Murrow May 1968 6 p refs Presented at the 3rd Natl. Conf. on Aerospace Meteorology, New Orleans, 6–9 May 1968

(NASA-TM-X-61215) CFSTI: HC $3.00/MF $0.65 CSCL 22A

As part of the planetary entry parachute program (PEPP) to provide performance data on parachute configurations proposed for use under flight conditions which might be encountered by a spacecraft attempting to soft-land on Mars, two-stage Honest John--Nike launch vehicles were used to drive a payload to the desired deployment conditions. Test objectives were to observe the deployment and inflation characteristics of each test parachute and to measure opening loads, all of which are greatly dependent on the initial Mach number (M) and dynamic pressure (q) deployment conditions; and to measure the drag and stability characteristics of the parachute during steady-stage descent. The radio command monitor display system is briefly described, error sources are identified, and the importance of meteorological data is stressed. The PEPP experience showed that parachute deployment conditions can be controlled effectively by using a radio command system when the test payload velocity and altitude are known on a real-time basis and recent meteorological data are available. However, results are limited, and a more reliable meteorological data gathering system above 30 km is considered necessary. M.G.J.

N68-34778*# Southwest Center for Advanced Studies, Dallas, Tex.

INDUCED MAGNETOSPHERE OF VENUS

Francis S. Johnson and James E. Midgley [1968] 6 p refs Presented at the Cospar 11th Plenary Meeting, Tokyo, 9–21 May 1968

(Grant NsG-269)

(NASA-CR-96787; F-16) CFSTI: HC $3.00/MF $0.65 CSCL 03B

It is suggested that the conductivity of the ionosphere of Venus (or Mars) gives rise to an induced magnetosphere formed by piling up magnetic field from the solar wind; it is assumed that the planet has no intrinsic field. Dessler has noted that the ionospheric conductivity is such as to seriously impede the convection of interplanetary field, causing field to build up to a stagnation value sufficient to divert the solar wind and cause a shock wave to develop. It is suggested here that collisions of solar wind particles with atmospheric particles will lead to further accumulation of field, thickening the region of stagnation field strength to the point where the solar wind is diverted at high enough altitude so that collisions with neutrals no longer significantly impede the flow. The outer boundary of the stagnation field region constitutes a magnetopause above which any ions formed from atmospheric particles are quickly swept away by the electric field associated with the solar wind; this level is identified with that near 500 km altitude where the daytime ionization drops off to an undetectable value. Author

N68-34798*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND AND GUST DESIGN CRITERIA FOR THE MARTIAN ATMOSPHERE

Robert M. Henry May 1968 7 p refs Presented at the 3rd Natl. Conf. on Aerospace Meteorology, New Orleans, 6–9 May 1968

(NASA-TM-X-61228) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Problems associated with the specification of wind and gust values for the Martian atmosphere were investigated in relation to the design of planetary spacecraft. While large-scale wind patterns for the Mars atmosphere are available on an overall or seasonal bases, there are no data on the gust component of the winds. Applicability of the earth analogy is considered in the absence of data on Mars, and, through the use of Richardson numbers, calculations of critical values of wind shear in the Martian atmosphere appear to be slightly lower than those for the earth. For the types of vehicle and missions expected for early Mars flights, the wind shear or gust gradient is considered an important parameter. A simple gust criteria is proposed that uses a trapezoidal or triangular shape with a specified gradient. Gust criteria of shape, gradient, magnitude, and length are superimposed on a profile of large-scale or mean winds; and the gust is applied at the point or points in the trajectory where the effects are most critical. M.W.R.

N68-34799*# Michigan Univ., Ann Arbor. Radio Astronomy Observatory.

MOTION AND STABILITY OF A SPINNING CABLE-CONNECTED SYSTEM IN ORBIT

S. A. Crist Dec. 1967 115 p refs Revised

(Grant NGR-23-005-131)

(NASA-CR-96628; Rept.-67-7) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A general approach is described for determining the stability and motion of a subsatellite-cable system. The system was analyzed assuming both a distributed mass and a lumped mass description of the connecting cable in which a linear elastic material was assumed. The lumped mass model, the dumbell, is used to examine the bounds on the types of motion which can occur within the energy levels of the conservative system. The bounds are found by determining the ficticous potential function for the dumbell system. It is shown that the motion of a dumbbell whose center mass moves in an undisturbed Keplerian orbit, and that of a light mass spinning about a very heavy mass which also moves in an undisturbed Keplerian orbit are almost identical and is referred to as a single mass model. The lumped analysis is justified by comparing natural frequencies obtained from both a distributed mass and a lumped mass analysis of the nonspinning cable. The effects of damping in the lumped model are considered and shown to be ineffective in damping out transverse motions. Also included is an example of how finite bodies may be incorporated into the lumped model to determine the modes of stability and motion for a cable connected system where the rigid body motion of the connected bodies may be important. B.S.D.

N68-34803*# American Science and Engineering, Inc., Cambridge, Mass.

A CONTINUATION OF A PROGRAM OF HIGH ANGULAR RESOLUTION STUDIES OF CELESTIAL X-RAY SOURCES Final Report, 19 Feb.–1 Aug. 1968

R. Giacconi, H. Gursky, P. Gorenstein, and H. Manko 1 Aug. 1968 31 p

(Contract NASw-1634)

(NASA-CR-96716; ASE-1987) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The general objectives of the X-ray astronomy program are reviewed, and the refurbishment and reflight of an instrumented payload on the Aerobee rocket are discussed. As door malfunctions on the first flight prevented data being obtained on cosmic X-ray sources, modifications were made on the door pulley and cables which allowed the door to swing open with little or no drag due to the cables which are used to reel in the door. An additional monitor for the door control relay was also added with outputs going to both the commutator and the control console. The characteristics of the aspect camera, proportional counters, collimators, telemetry, and the automatic control system (ACS) are listed. Laboratory tests were conducted to simulate the thermal conditions of the launch. Although the payload was recovered intact and the instrumentation operated satisfactorily, the original experiental objectives were not achieved due to a timer malfunction in the ACS. M.G.J.

N68-34806*# Michigan Univ., Ann Arbor. Radio Astronomy Observatory.
ENGINEERING FEASIBILITY STUDY OF A KILOMETER WAVE ORBITING TELESCOPE, PHASE 2 Final Report
Fred T. Haddock Jul. 1968 13 p refs
(Grant NGR-23-005-131)
(NASA-CR-96629) CFSTI: HC$3.00/MF$0.65 CSCL 22A

Summary data are presented on the structural dynamics and antenna electrical properties of the kilometer wave orbiting telescope (KWOT). The planar motion of a lumped-mass model representing the KWOT structure was numerically analyzed. The results indicate that the amplitude of the structural oscillations excited by the deployment method are within the limits defining allowable structural distortion. Analytical studies were also conducted on the motion and stability of a spinning cable-connected system in orbit, and on the effect of resistive losses on the current distribution of long, thin cylindrical antennas. Results of the systems investigation show that the basic KWOT is considered attractive for the following reasons: (1) It lies entirely in a plane. (2) The rhombic antenna has a unidirectional beam which lies in the plane of the structure, and has directivity in both the E and H plane, is relatively broadband, and requires no interconnecting transmission lines. (3) The KWOT structure is compact when stowed, but is easy to deploy and adjust. (4) The KWOT antenna generates a real beam, which is physically scanned over the celestial sphere in a controlled manner. M.G.J.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N68-33683*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUCCESSFUL RESTART OF A CRYOGENIC UPPER-STAGE VEHICLE AFTER COASTING IN EARTH ORBIT
Kenneth W. Baud, Steven V. Szabo, Jr., Ronald W. Ruedels, and James A. Berns Washington Sep. 1968 44 p refs
(NASA-TM-X-1649) CFSTI: HC$3.00/MF$0.65 CSCL 22D

Successful engine restart in space of an upper stage vehicle using cryogenic propellants was accomplished for the first time with the flight of the Atlas-Centaur vehicle, AC-9. The problems unique to the restart of a vehicle using cryogenic propellants and the design concepts for solving these problems on Centaur are discussed. AC-9 flight data pertinent to the problems are also presented. Author

N68-33738*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN EXPANDABLE GAS BAG CONCEPT FOR A STOWABLE, OMNIDIRECTIONAL, MULTIPLE-IMPACT LANDING SYSTEM
John R. McGehee [1967] 7 p refs Presented at the AIAA/ASME 8th Struct. Structural Dyn., and Mater. Conf., Palm Springs, Calif., 29–31 Mar. 1967
(NASA-TM-X-59623) CFSTI: HC$3.00/MF$0.65 CSCL 22B

A landing system consisting of a payload surrounded by a radially compartmented spherical gas bag is proposed. Vehicle kinetic energy is dissipated as a consequence of gas flow characteristics through orifices in the compartment walls. Multiple impact capability is obtained by retaining the gas within the bag. The impact characteristics of a simple test vehicle consisting of a compartmented cylinder attached to a collapsible gas bag were investigated experimentally to determine the energy dissipation capabilities. Analytical expressions based on one-dimensional flow theory were obtained for acceleration, velocity, stroke, and compartment pressures for the test vehicle as well as for spherical gas bag landing systems. Experimental and analytical results were in good agreement; values of kinetic energy dissipated by the test system agree within 5%. In the experiments the kinetic energy dissipated was as great as 90% of the kinetic energy of test vehicle at touchdown. Comparable energy dissipation was also obtained from preliminary computations for an earth landing of the proposed system. Author

N68-33963# European Space Operations Center, Darmstadt (West Germany). Control Center Div.
OPERATIONS PLAN FOR ESRO 2, VOLUME 3
I. Rodger, ed. Paris ESRO Apr. 1968 51 p
CFSTI: HC$3.00/MF$0.65

The prelaunch activities, i.e. network preparation, spacecraft countdown, and composite countdown schedule, are described as well as the early orbit scheduling. The routine phases and emergency procedures, i.e. station faults and ESRO 2 F2 potential frequency conflicts, are discussed. ESRO

N68-34018*# California Univ., Santa Barbara.
ADVANCED MARS ORBITER AND SURVEYOR: A CONCEPTUAL DESIGN BY THE NASA SPACE TECHNOLOGY SUMMER INSTITUTE
William T. Thomson 1968 211 p refs Symp. held at Santa Barbara, Calif., 24 Jun.–2 Aug. 1968
(Contract NSR-05-010-021)
(NASA-CR-98625) CFSTI: HC$3.00/MF$0.65 CSCL 22B

The spacecraft proposed for advanced Mars exploration has been designed with three major goals in mind: 1) obtaining high resolution pictures of portions of the planet, 2) obtaining an accurate surface profile of the planet, and 3) landing a mobile laboratory on the Martian surface. Pictures of 2 meter resolution will be obtained using a multi-spectral line scanning camera. A laser radar profile mapping system incorporated into the multi-spectral camera will let it accomplish the first two project goals simultaneously. The spacecraft has been designed to accommodate the camera and lander. In order to deal with the tremendous earthward data transmission rates required for high resolution pictures (on the order of 10^7 bits per second), laser communication will be used for the earth downlink. A more standard microwave system will provide the earth uplink, lander/orbiter communications, and the earth downlink during transit to Mars. Power for the spacecraft will be provided by large roll-out solar arrays. The large arrays will provide 2000 square feet of solar panel area, enough to supply the required 10 kilowatts at Mars. Author

N68-34060*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 1: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): SUMMARY

Washington NASA Sep. 1968 65 p refs
(Contract NAS1-7977)
(NASA-CR-66665-1; G346) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Selection of a capsule concept for the 1973 launch opportunity was the primary emphasis of a Mars soft lander study, and five concepts were developed with capsule weights from 1200 to 1600 lb. Mission and system parametric studies were made that indicate a capsule weighing less than 1500 lb can perform a significant scientific mission despite the present uncertainty of the Martian environment. Concept I, designed for a one-day mission and modified environment constraints, is the minimum weight capsule; Concept II, also for a one-day mission, uses a more conservative nominal environment and flexibility constraints; Concept III uses nominal constraints, but has 90-day lifetime capability; Concept V has 90-day capability with modified constaints. Concept IV, with a projected 2-year lifetime was abandoned. Maximum aeroshell diameter was limited to 178 in. to permit use of booster payload shrouds no greater than 18 ft in dia. A 10-ft payload shroud, that eliminates the need for hammerheadings, was used in Concepts I and V. M.W.R.

N68-34051*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 2: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): INTRODUCTION AND PARAMETRIC STUDIES
Washington NASA Sep. 1968 395 p refs
(Contract NAS1-7977)
(NASA-CR-66665-2; G346) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Mission and systems parametric studies are detailed for a Martian soft lander to define the entry and landing capsule concepts suitable for Mars exploration in the 1970's. To identify the effects of the assumed environment description, a parametric environment sensitivity analysis was performed; and cost trends were analyzed, with various design concepts ranked to identify minimum cost concepts. Mission parametric studies detailed launch, arrival, and orbit; deorbit and descent; entry, and terminal deceleration. The science payload was considered, along with the communications, power, guidance and control, and sequencer systems. These parametric study results related capsule system design parameters to performance. M.W.R.

N68-34052*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 3: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): PARAMETRIC STUDIES CONTINUED
Washington NASA Sep. 1968 301 p refs
(Contract NAS1-7977)
(NASA-CR-66665-3; G346) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Additional system parametric studies of a Mars soft lander for a 1973 launching are reported along with a capsule parametric analysis and a review of Martian environment effects. Systems considered are thermal control flight and landed phases; deorbit, attitude control, and terminal propulsion; auxiliary aerodynamic acceleration; aeroshell; landing; and canister and adapter. Delivery systems and surface payload activities, descent and entry, terminal deceleration, and delivery system capability are detailed. The surface payload is considered separately since its performance or operational characteristics are essentially independent of capsule delivery system. Surface payloads designed for continuous cold must be considerably heavier than those designed for a cyclic environment; and radioisotope heaters are considered the best means of providing heat. The relay mode of data transmission allows for lighter and less complex surface payloads than does the direct mode. Entry and surface environment as well as flight capsule sensitivity are discussed. M.W.R.

N68-34053*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 4: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): CONCEPTUAL DESIGN 1
Washington NASA Sep. 1968 152 p refs
(Contract NAS1-7977)
(NASA-CR-66665-4; G346) CFSTI: HC $3.00/MF $0.65 CSCL 22B

System configuration, major systems, and weight are reviewed for the Concept I capsule for a Mars soft lander 1973 launching. The 8.3 ft capsule aeroshell was configured to fit the 10-ft dia shroud; and the 1226 lb capsule was designed to perform the minimum one-day mission with acceptable risk and least cost. The proposed mission consists of entry and surface atmospheric measurements, post-landed imaging, and soil composition measurements. A boost and earth deorbit, interplanetary, and a Mars orbit phase are included; followed by separating capsule from orbiter, performing deorbit maneuver, and descending and entering Mars' atmosphere. Final deceleration is to be provided by parachute and three engine throttleable monopropellant propulsion system; and thermal environment after landing is to be maintained by isotope heaters, heat sink, and insulation. Details are included for the sterilization canister, adapter, aeroshell, and lander. Major systems described are entry and landed science, communication, power, guidance and control, sequencer, thermal control, propulsion, auxiliary aerodynamic decelerator aeroshell, landing, canister, and adapter. M.W.R.

N68-34054*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 5: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): CONCEPTUAL DESIGN 2
Washington NASA Sep. 1968 48 p refs
(Contract NAS1-7977)
(NASA-CR-66665-5; G346) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Concept II for the Mars soft lander capsule was designed for launching in 1973 for a one-day mission in a nominal environment and within flexibility constraints. Like the Concept I capsule, Concept II, which weighs 1450 lb, does not include redundant components. A 52-lb weight increase in the capsule for redundant components would result in a .71 reliability and require an increase in aeroshell diameter to 11.1 ft to maintain nominal deployment Mach number of 2.0. In the Concept I capsule this reliability is predicted with a 38-lb weight increase and no change in aeroshell diameter size, and would result in a maximum deployment Mach number of 1.68. System configuration and major systems are detailed, and a weight summary of the various systems and components is included. M.W.R.

N68-34055*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 6: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): CONCEPTUAL DESIGN 3 AND 4
Washington NASA Sep. 1968 157 p refs
(Contract NAS1-7977)
(NASA-CR-66665-6; G346) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Details are presented on the system configuration and major systems of the Concept III capsule for the 1973 launching of the Mars soft lander, and mention is made of Concept IV which was abandoned to permit concentration on four other capsule concepts. The 1603-lb Concept III capsule, designed to perform the minimum science mission for a 90-day period, was based on nominal environmental constraints and mission flexibility. Aeroshell diameter of 11.5 was planned for the capsule, which would be capable of relay transmission of ten million bits of data per day early in the mission and whenever the orbiter was available for the relay. A low rate S-band system would be used for communications at other times during the mission lifetime. While the concept was

designed for 90 days' operation at nominal mode, actual lifetime may exceed this or may be terminated by battery failures, degraded solar cell output, or other equipment failure. A .71 reliability for the Concept III capsule would require 56 additional pounds and increased aeroshell diameter to 11.8 ft to insure deployment at Mach number 2.0. M.W.R.

N68-34056*# McDonnell-Douglas Co., St. Louis, Mo. Eastern Div.
SOFT LANDER, PART 7: MARS SOFT LANDER CAPSULE STUDY (ENTRY FROM ORBIT): CONCEPTUAL DESIGN 5
Washington NASA Sep. 1968 154 p refs
(Contract NAS1-7977)
(NASA-CR-66665-7; G348) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Concept V capsule for a Mars soft lander launching in 1973 was designed to perform the minimum science mission for a period of 90 days with acceptable risk and least cost. System configuration and major systems are detailed for the 1313 lb capsule with aeroshell diameter of 8.83 ft. Relay transmission of ten million bits per day is assumed early in the mission or when the orbiter is available, and low rate S-band communications directly to the earth are planned for other times. Because it was designed to survive a less than nominal environment severity, the Concept V capsule is somewhat vulnerable to enviroment uncertainty. The additional 48 lb necessary to achieve .71 reliability of the capsule is considered compatible with the capsule's size and a nominal deployment Mach number of 1.93 would result. M.W.R.

N68-34063# European Space Research Organization, Paris (France).
ESRO SOUNDING ROCKET ACTIVITY
In its ESRO Bull. No. 4, 1967 p 4–10 refs (See N68-34062 21-30)

Sounding rocket launchings carried out within the first half of ESRO's initial 8-year period are described, and the scientific results summarized. Details of the program for the immediate future are given. ESRO

N68-34066# European Space Research Organization, Paris (France).
PROGRESS IN OPERATIONAL PROGRAM [ETAT D'AVANCEMENT DU PROGRAMME OPERATIONNEL]
In its ESRO Bul. No. 4, 1967 p 23–26 In FRENCH (See N68-34062 21-30)

The ESRO sounding rocket program has been continued with four Skylark rocket launchings from Sardinia and three Dragon rocket launchings from Andoya. Details of these launchings as well as preliminary results of a campaign at Kiruna in late November are presented. Finally a report is given on the progress in the development of the ESRO-I, ESRO-II, HEOS-A, TD-1 and TD-2 satellites and the Large Astronomical Satellite. ESRO

N68-34070*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
TEMPERATURE CONTROL OF THE MARINER VENUS 67 SPACECRAFT
L. N. Dumas 15 Jul. 1968 56 p refs
(Contract NAS7-1100)
(NASA-CR-96708; JPL-TR-32-1284) CFSTI: HC $3.00/MF $0.65 CSCL 22B

On October 19, 1967, the Mariner V spacecraft successfully encountered Venus and obtained scientific information about the planet. The variation in solar intensity during the mission made effective solar isolation a requirement for spacecraft survival. The temperature control design is presented, with emphasis on the design features which provided this isolation. The results of thermal testing and flight temperature data are summarized and discussed. Author

N68-34075# European Space Research Organization, Paris (France).
PROGRESS IN OPERATIONAL PROGRAM [ETAT D'AVANCEMENT DU PROGRAMME OPERATIONNEL]
In its ESRO Bul. No. 3, 1967 p 20–22 In FRENCH (See N68-34072 21-30)

The first results of a sounding rocket launching campaign in July and August 1967 are briefly summarized. A preview of campaigns in Andoya and Sardinia is given. Progress on the ESRO-1, ESRO-2, HEOS-A, TD-1 and TD-2 satellite projects and the Large Astronomical Satellite is stated. ESRO

N68-34083# European Space Research Organization, Paris (France).
THE TD-1, TD-2 SATELLITES
In its ESRO Bull. No. 2, 1967 p 5–9 (See N68-34081 21-30)

The historical background and general structural and orbital characteristics for these satellites are given. The scientific experiments to be included in the payloads are enumerated. ESRO

N68-34085# European Space Research Organization, Paris (France).
PROGRESS IN OPERATIONAL PROGRAMME
In its ESRO Bull. No. 2, 1967 p 13–14 (See N68-34081 21-30)

Brief details are given on two launching campaigns in Sardinia in May, the first launching of ESRO-II from California, the prototype of ESRO-1 and progress in respect of HEOS-A, TD-1 and TD-2 satellites. ESRO

N68-34097# European Space Research Organization, Paris (France).
THE ESRO-2 SATELLITE
In its ESRO Bull. No. 1, 1967 p 2–15 (See N68-34096 21-30)

The historical background, initial development, and implementation and management of the ESRO-2 satellite project are reviewed. The scientific aims are enumerated, orbital characteristics mentioned and the spacecraft described. The control system for the launch vehicle (Scout rocket) and the tracking and telemetry network are also dealt with. ESRO

N68-34098# European Space Research Organization, Paris (France).
PROGRESS IN OPERATIONAL PROGRAMME [ETAT D'AVANCEMENT DU PROGRAMME OPERATIONNEL]
In its ESRO Bull. No. 1, 1967 p 16–19 In FRENCH and ENGLISH (See N68-34096 21-30)

Sounding rocket launchings at Kiruna in November 1966 and February 1967 and in Sardinia in November 1966 are reviewed. Progress made in the development of ESRO-2, ESRO-1, HEOS-A, TD-1, TD-2 satellites and the Large Astronomical Satellite is stated. ESRO

N68-34128# Rome Univ. (Italy).
ELECTRONIC INSTRUMENTATION FOR SAN MARCO 2 [STRUMENTAZIONE ELETTRONICA DEL SAN MARCO 2]
Giorgio Ravelli Jun. 1967 11 p In ITALIAN; ENGLISH summary
Its Atti del Centro Ric. Aerospaziali 15-c
CFSTI: HC $3.00/MF $0.65

The electronic instrumentation carried by the San Marco 2 aeronomy satellite is described and the design criteria and the reasons for the chosen solutions are examined for each system. Author (ESRO)

N68-34133# Royal Aircraft Establishment, Farnborough (England).
DETERMINATION OF THE ATTITUDES OF THE SKYLARK ROCKET IN FREE SPACE
P. J. Herbert Dec. 1967 31 p refs Presented at the AIAA Sounding Rocket Vehicle Technol. Specialist Conf., Williamsburg, Virginia, 27 Feb.–1 Mar. 1967
(RAE-TR-67319) CFSTI: HC $3.00/MF $0.65

A mathematical model is defined, which describes the attitude motion in terms of a number of parameters. Data from solar and magnetic sensors are used in a least squares method to determine best values for the parameters. The rocket magnetization changes during boost and hence the pre-flight magnetometer calibrations are virtually useless. However, the magnetization remains constant in free space, and a method is presented which separates this body-fixed magnetization of the rocket from the measured combined magnetic field due to rocket magnetization and the earth's field. The change in direction of the earth's field throughout the trajectory is also taken into account. In order to apply the least squares method, initial estimates of the parameters defining the motion are required. The derivation of these estimates is described. Author (ESRO)

N68-34171# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

RECOVERABLE SOUNDING ROCKET. PARAGLIDER VERSION [RUECKFUEHRBARE HOEHENFORSCHUNGS-RAKETE. PARAGLEITER-VERSION]

H. Häuser Apr. 1968 46 p In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMWF-FBW-68-26) CFSTI: HC$3.00/MF$0.65

The guided recovery of a sounding rocket with paraglider has been successfully tested during radio-controlled gliding flights at a rocket test range in Sardinia. The full-scale glide-test vehicles were equipped with deployable and flexible wings, the paraglider; sensors and telemetry and telecommand units had been installed for the distant control and the measurement of the characteristics of flight mechanics. The results obtained from 14 flight trials show that the vehicle has sufficient dynamic stability and is well maneuverable in the investigated incompressible subsonic speed range. Wind tunnel measurements have been confirmed; the measured flight characteristics are in agreement with those obtained during the flight simulation based on theoretical methods. Subject of further developments will be the performance of flight trials in order to test the paraglider recovery system in the transonic and supersonic velocity range. The vehicles to be developed for this purpose will be equipped with rocket motors and an extended telemetry and telecommand system, retaining the approved configuration of the system. Author (ESRO)

N68-34172# Royal Aircraft Establishment, Farnborough (England).

THE ION ENGINE AND LARGE SOLAR ARRAY FOR THE X5 SPACECRAFT

B. P. Day and F. C. Treble 1968 28 p refs Presented at the 1st Ann. Meeting of the Brit. Interplanet. Soc., Southampton, Engl. 24–25 Apr. 1968
CFSTI: HC$3.00/MF$0.65

A description is given of the ion engine and the 550W deployable solar array proposed for the Black Arrow X5 spacecraft. Problem areas are discussed and an indication is given of the present state of development. Author (ESRO)

N68-34194# Bölkow Entwicklungen K. G., Munich (West Germany).

THIRD STAGE OF THE ELDO-A LAUNCHER EUROPA-1 [3. STUFE DER ELDO-A-TRAEGERRAKETE EUROPA-1] Annual Report, 1 Jan.–31 Dec. 1967

Arbeitsgemeinschaft Satellitentraegersystem 30 Apr. 1968 237 p In GERMAN Prepared jointly with Entwicklungsring Nord for ELDO
CFSTI: HC$3.00/MF$0.65

Report on the tasks performed by ERNO and Bölkow during 1967 on the third stage of the ELDO launch vehicle. ESRO

N68-34196# Société pour l'Etude et la Réalisation d'Engins Balistiques, Courbevoie (France). Direction Technique.

HEOS B: INTERPLANETARY MISSIONS. SUPPLEMENT TO ELDO STUDY NO. 9.3 [HEOS B: MISSIONS INTER-PLANETAIRES. SUPPLEMENT A L'ETUDE ELDO NO. 9.3]

19 Feb. 1968 66 p refs In FRENCH Prepared for ELDO
(DTA-3-NO.30/9591) CFSTI: HC$3.00/MF$0.65

The HEOS-B satellite project considers possible interplanetary missions for an ELDO-A three stage launch vehicle carrying a solid propellant fourth stage. The trajectories required to reach polar orbit of 300 km perigee and 250,000 km apogee are discussed. ESRO

N68-34205*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

CONTAMINANTS VS MICROMETEORITES FROM THE 1965 LEONID METEOR SHOWER

M. B. Blanchard, N. H. Farlow, G. V. Ferry, and H. D. Shade (Tracerlab, Richmond, Calif.) [1967] 36 p refs
(NASA-TM-X-60321) CFSTI: HC$3.00/MF$0.65 CSCL 16C

Particles found on collecting surfaces exposed by Ames Luster Rocket Payload reflect a quantity of contaminants from several sources. Payload activities and particle studies were performed in a Fed Std 209, Class 100, environment. Separating collected specimens from contaminants required optical mineralogy, density, X-ray diffraction, and electron microprobe analyses. To eliminate contaminants from future collections it was necessary to determine the effectiveness of current cleanliness control measures. Tests indicated the following were principal contaminant sources: (1) leaks in HEPA filters, (2) leaks and design deficiencies in laminar flow benches, (3) clean room garment materials and their laundering, (4) valve location relative to filter elements and materials used in fluid filtration systems, (5) cleaning and processing methods, and (6) payload design and fabrication materials. Author

N68-34206# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

RELIABILITY ANALYSIS FOR A RECOVERABLE SOUNDING ROCKET WITH FLEXIBLE WINGS [ZUVERLASESSIGKEIT-SANALYSE ZU EINER GEZIELT RUECKFUEHRBAREN HOEHENFORSCHUNGSRAKETE MIT PARAGLEITER-FLUGEL

K. Schürger and K. Stopfkuchen May 1968 67 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. für Wiss. Forschung
(BMwF-FBW-68-32) CFSTI: HC$3.00/MF$0.65

A reliability analysis of the recovery system of a sounding rocket with flexible wings is made. The rocket as well as the telemetry and the telecommand systems are taken into consideration. For failure investigations the sounding rocket with extended wings is simulated by means of an analog computer. The dynamic stability is proved using a linearized mathematical model. The results of the failure simulation and the failure rates of the electronic components of the several subsystems are the input data for calculating the reliability of the whole system. To calculate the reliability logic flow diagrams are used. Author (ESRO)

N68-34238# European Space Research Organization, Paris (France).

ESRO/ELDO BULLETIN NUMBER 1

May 1968 36 p In FRENCH and ENGLISH Prepared jointly with ELDO
CFSTI: HC$3.00/MF$0.65

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N68-34240# European Space Technology Center, Noordwijk (Netherlands).
THE EUROPEAN EFFORTS IN THE FIELD OF TELECOMMUNICATION SATELLITES [LES EFFORTS EUROPEENS DANS LE DOMAINE DES SATELLITES DE TELECOMMUNICATIONS]
P. Blassel and R. Collette *In* ESRO/ELDO Bul. No. 1 May 1968 p 12–18 In FRENCH (See N68-34238 21-31)

The history of the European telecommunication satellite program goes back to 1963 and its stages of planning since then are recalled. The initial proposal of two versions of experimental telephony and television distribution satellites to be launched by the proposed ELDO–PAS rocket (SAROS 2 project) had to be restricted to one satellite project (CETS C or EURAFRICA) which is distinct from the French/German SYMPHONIE satellite and which should provide international liaison during transmission. This satellite itself and its mission are described in some detail. ESRO

N68-34241# European Space Research Organization, Paris (France).
PROGRESS IN OPERATIONAL PROGRAM [ETAT D'AVANCEMENT DU PROGRAMME OPERATIONNEL]
In its ESRO/ELDO Bull. No. 1 May 1968 p 20–22 In FRENCH and ENGLISH (See N68-34238 21-31)

The sixth sounding rocket campaign from ESRANGE for wind and temperature measurements in the upper atmosphere and investigation of auroral particles is followed up and a preview of the next campaign given. The development of the ESRO satellite program is briefly mentioned. ESRO

N68-34249# Royal Aircraft Establishment, Farnborough (England).
BLACK ARROW FLIGHT SEQUENCE AND PERFORMANCE
J. B. Scott 1968 16 p Presented at the 1st Ann. Meeting of the Brit. Interplanet. Soc., Southampton, Gt. Brit., 24–25 Apr. 1968
CFSTI: HC $3.00/MF $0.65

The characteristics of the Black Arrow launch vehicle are given and the flight sequence is described. The reasons for selecting a solid propellant motor for the third stage are explained. The restrictions on launching directions at Woomera (Australia) are considered and further improvements to the vehicle are suggested. ESRO

N68-34250 Hawker Siddeley Dynamics, Ltd., Hatfield (England). Space Projects Div.
ELDO STUDY NO. 8.2: FEASIBILITY STUDY OF VEHICLES USING LARGE SOLID BOOSTERS AS FIRST STAGE AND BLUE STREAK AS SECOND STAGE
Jan. 1968 187 p refs Prepared for ELDO
(Contract-CTR-17/7/25)
(HSD-TP-7090)

The concept of a vehicle using large solid boosters as a first stage, Blue Streak as a second stage plus suitable high energy upper stage systems to launch 2 tons into synchronous orbit is examined and found feasible. ESRO

N68-34254# Rome Univ. (Italy).
TRIAXIAL BALANCING PROBLEMS. SAN MARCO 2 SATELLITE BALANCING [PROBLEMI DEL BILANCIAMENTO TRIASSIALE. IL BILANCIAMENTO DEL SATELLITE SAN MARCO 2]
Ugo Ponzi Jun. 1967 27 p In ITALIAN; ENGLISH summary *Its* Atti del Centro Ric. Aerospaziali 15-f
CFSTI: HC $3.00/MF $0.65

After a survey of the fundamental principles connected with the balancing, the general problem of the triaxial balancing is dealt with and the main operational difficulties and the more frequent causes of errors are shown. Then the problem is investigated of how proceeding with a triaxial balancing in practical cases, and the results obtained with the suggested procedure from the balancing of San Marco 2 satellite are shown. Author (ESRO)

N68-34273 Hawker Siddeley Dynamics, Ltd., Hatfield (England). Space Projects Div.
ELDO STUDY NO. 3.8: THE PERFORMANCE STUDY OF TWO-STAGE SATELLITE LAUNCHING VEHICLES
C. T. Wilkins Dec. 1967 123 p refs Prepared for ELDO
(Contract CTR/17/7/24)
(HSD-TP-7100)

Optimum sizes for hydrogen/oxygen second stages which, when used with a Blue Streak first stage of either ELDO A (F10) or ELDO B2 standard, will achieve the maximum possible payloads into seven orbits, launched from an equatorial site. A choice of either 1, 2, 4 or 5 motors was considered for the second stage. These combinations led to the consideration of 56 optimum vehicles. Certain engineering constraints were observed in this performance optimization study, namely: the upper and lower limits of apparent acceleration, aerodynamic heating, loadings and control requirements. Author (ESRO)

N68-34279*# Boeing Co., Seattle, Wash.
STUDY OF POWERED SPACECRAFT FOR MARS MISSIONS. PERFORMANCE, SUBSYSTEMS, AND CONFIGURATIONS Final Report
Washington NASA Sep. 1968 373 p refs
(Contract NAS1-7995)
(NASA-CR-66668; D2-140028-5, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This volume provides parametric performance data, conceptual configuration studies, subsystem definition and trades, and operational data for a Mars exploration powered spacecraft launched by a Titan IIIC or IIID in 1973. In addition, refined mission and preliminary design analyses are provided for two specific cases. Author

N68-34331# Rome Univ. (Italy). Scuola di Ingegneria Aerospaziale.
SCIENTIFIC AND TECHNICAL ASPECTS OF SAN MARCO SATELLITE [ASPETTI SCIENTIFICI E TECNICI DEL SATELLITE SAN MARCO]
Luigi Broglio Jun. 1967 23 p In ITALIAN; ENGLISH summary *Its* Atti del Centro Ric. Aerospaziali 15-b
CFSTI: HC $3.00/MF $0.65

The main aim of the San Marco project and the satellite technique for measuring the atmosphere density are examined. The satellite structure which consists mainly of an external thin shell and an internal drum elastically connected in a way that relative displacement is proportional to the total force F applied on the elastic connection is described. In the measurements range this force consists of two terms. The first one is practically the aerodynamic drag, the second one is an inertial force which becomes an important term only when the aerodynamic forces are very small. Further, the satellite motion is compared with that of a gyroscopic body and the validity of this theoretical scheme is explained. Finally, other experiments carried out by the San Marco 2 satellite are described. Author (ESRO)

N68-34352# National Environmental Satellite Center, Washington, D. C.
THE IMPROVED TIROS OPERATIONAL SATELLITE
Edward G. Albert Aug. 1968 21 p
(NESCTM-7)

Briefly described are the improved TIROS satellite environmental sensors and the their operational performance. These sensors provide photographic coverage of the illuminated portion of the earth's surface and global radiating surface temperature measurements by infrared radiometry. Video data are broadcast immediately to ground station receivers. The spacecraft's structure is box like and powered by solar panels. G.G.

N68-34393*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EARTH ORBITAL LOGISTICS SPACECRAFT: PERFORMANCE ASPECTS AND VEHICLE CONCEPTS
Eugene S. Love [1968] 59 p refs Presented at the SAE Space Technol. Conf., Washington, D. C., 8–10 May 1968
(NASA-TM-X-61216) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Implications of hypersonic performance are reviewed with emphasis on return of logistics spacecraft from orbit to the continental U.S. Considered are quick return, delayed return with varying and fixed wait time, relationships of wait time to return opportunities and maneuverability to clear-weather recovery and night landing, propulsive orbit phasing, propulsive plane change, and recovery costs. Observations are made in relation to current spacecraft capability and future needs. Representative vehicle concepts ranging from low to high hypersonic lift-drag ratios are discussed. Particular attention is centered on landing modes and their implications. Discussed are fixed and variable geometry for runway landers, and decoupled modes, such as parawing and sailwing devices, deployable rotors, and propulsive lift. Author

N68-34401*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DELTA, AND UPRATED DELTA, CAPABILITIES, CONSTRAINTS, COSTS
Charles R. Gunn Sep. 1968 13 p
(NASA-TM-X-6334; X-470-68-357) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Performance, flight environment, spacecraft integration requirements, launch availability, and costs are provided. Delta is composed of a long tank Thor first stage, Delta second stage (evolved from the Vanguard and Able–Star programs), and a solid propellant third stage motor that is an adaptation of the Surveyor spacecraft retromotor. Uprated Delta is composed of the present first and third stages and fairing, integrated with a new hydrogen/oxygen second stage that utilizes shortened Thor tanks, Saturn 4B hydrogen tank internal insulation, a single Centaur RL-10 engine, and Delta second stage control electronics and peripheral tracking, data, range safety, and power systems. Uprated Delta increases the synchronous transfer capability from 785 to 2395 pounds. A Delta launch cost of $4.0 million is detailed. The projected Uprated Delta launch cost of $5.5 million and its $30 million estimated development cost are discussed. Author

N68-34415# Rome Univ. (Italy). Scuola di Ingegneria Aerospaziale.
SAN MARCO 2 SATELLITE TESTS ON THE GROUND: THERMAL CONTROL SYSTEM TEST [SPERIMENTAZIONE A TERRA DEL SATELLITE SAN MARCO 2: LE PROVE SUL SISTEMA DI CONTROLLO TERMICO]
Carlo Arduini Jun. 1967 22 p In ITALIAN; ENGLISH summary *Its* Atti del Centro Ric. Aerospaziali 15-d
CFSTI: HC $3.00/MF $0.65

The San Marco 2 satellite, launched in April, 1967 from the S. Marco Equatorial Range, was extensively tested at the ground. This development and qualification test program can be considered one of the main factors of the successful orbital operation of the satellite. Some of the main techniques and related results of the test program for the thermal control subsystem of S. Marco 2 are briefly described. Author (ESRO)

N68-34498*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE SMALL ASTRONOMY SATELLITE (SAS) PROGRAM
Marjorie R. Townsend Sep. 1968 39 p
(NASA-TM-X-63333; X-724-68-351) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This report provides a description of the Small Astronomy Satellite (SAS). As one of NASA's newest Explorer class programs, it has the capability of providing at relatively low cost, much basic, previously unavailable information concerning low and high energy radiation emanating from sources both inside and outside of our galaxy. Sufficient information is given concerning its volume, weight, power, commands, telemetry and control system to ascertain its ability to perform specific astronomy experiments. Project reliability requirements and environmental test conditions are included in the appendix. Author

N68-34587*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONCEPT FOR A LARGE MULTIPURPOSE LAUNCH VEHICLE
Edward W. Gomersall and John G. Brunk (Boeing Co.) [1968] 29 p refs Presented at the SAE Space Technol. Conf., Washington, D. C., 8–10 May 1968
(NASA-TM-X-61237) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The key results of a study of a large multipurpose launch concept are summarized. The study involved, through parametric performance and detailed design analyses, the characteristics of an attractive launch vehicle approach for consideration in future mission planning studies. The reported vehicle system has only two stages: a LOX/LH_2 main stage and a solid-motor strap-on stage. The main stage has the performance capability to fly single stage to orbit and the structural capability to accommodate strap-on stages to achieve a broad range of payload flexibility. The salient features of the vehicle system, sized to deliver one to four million pounds to low earth orbit, are described. The major resource and technology implications of the system are discussed. Author

N68-34657# General Dynamics/Convair, San Diego, Calif.
POTENTIAL ORBITAL FACILITIES FOR SOFT X-RAY AND LONG WAVE RADIO ASTRONOMY
M. C. Nilson [1967] 44 p refs Presented at the 125th Meeting of the Am. Astron. Soc., Philadelphia, 4–7 Dec. 1967

A design study is presented for a large imaging X-ray telescope for the 2 to 300Å region and a long wave radio astronomy interferometer system. The telescope is intended for a low inclination, low altitude earth orbit on a Saturn IB manned launch; the interferometer for launch into synchronous altitude orbit on a Saturn V vehicle. Lens assembly, grazing incidence mirrors, and detector housing assembly are described for the telescope along with its imaging, spectrometry, and polarimetry capabilities. Man's participation in the use of the telescope and the interferometer is described, as are design goals for both. The general configuration of the interferometer is presented including the center body, boom assembly, dipoles and attitude control jets, and weight. Antenna characteristics and scientific instrumentation are described. M.W.R.

N68-34765# Société pour l'Etude et la Réalisation d'Engins Balistiques, Courbevoie (France). Direction Technique.
ELDO STUDY NO. 9.3: PERFORMANCES AND APPLICATIONS OF AN ELDO-A LAUNCHER, EQUIPPED WITH A PERIGEE MOTOR—LAUNCHER ELDO-A/PS [ETUDE ELDO NO. 9.3: PERFORMANCES ET CONDITIONS D'EMPLOI D'UN LANCEUR ELDO-A, MUNI D'UN MOTEUR DE PERIGEE—LANCEUR ELDO-A/PS]
27 Nov. 1967 142 p refs In FRENCH Prepared for ELDO
(NT/DTA/GI-III/67/NO.115) CFSTI: HC $3.00/MF $0.65

The ELDO launcher-A/PS consists of the ELDO A launcher with a perigee motor which injects a 360 kg. consisting of an apogee motor plus the satellite, into an elliptical orbit, whose perigee is 300 km and whose apogee 36,000 km. The present study defines space missions for an ELDO-A/PS launcher, fired from French Guiana and calculates the corresponding performance and parameters which set limitations to the conditions of applicability of such a system. ESRO

N68-34771 # Société pour l'Etude et la Réalisation d'Engins Balistiques, Courbevoie (France). Direction Technique.
ELDO INITIAL PROGRAM—STUDY NO. 7.4: PERFORMANCES OF THE ELDO-A-F10 LAUNCHER; CIRCULAR ORBITS, ELLIPTICAL ORBITS [ELDO, PROGRAMME INITIAL: PERFORMANCES DU LANCEUR ELDO-A-F10; ORBITES CIRCULAIRES, ORBITES ELLIPTIQUES]
30 Oct. 1967 70 p In FRENCH Prepared for ELDO (DTA/3-NO.12/9174) CFSTI: HC $3.00/MF $0.65

Performance data for the ELDO A launch vehicle (F10) which will be launched from an equatorial base in French Guiana are predicted. Circular and elliptical orbits are considered for two types of injection into orbit with continuous thrust. ESRO

N68-34801*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A PYROTECHNIC-ACTIVATED CALORIMETER FOR FLIGHT RESEARCH AT LUNAR RETURN VELOCITY
Don D. Davis, Jr. and Clotaire Wood [1968] 17 p Presented at the Intern. Colloq. on the Util. of Pyrotech. and Explosive Elem. in Space Systems, Tarbes, France, 9–12 Jul. 1968 (NASA-TM-X-61210) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Discussed is the unique application of a pyrotechnic device to solve a problem that was encountered in the design of the reentry package for Project Fire. Project Fire was undertaken to investigate the heating environment of vehicles entering the earth atmosphere at velocities slightly greater than lunar return velocities. The primary objective was to obtain onboard measurements that would define the hot-gas radiance and the total heating on a blunt nosed body of fairly large scale. These results were needed to test various theoretical and empirical heat transfer prediction techniques that had been proposed by individual research scientists, as well as others that would be proposed in the future. The objective was met by lifting a powered spacecraft above the atmosphere with an Atlas launch vehicle and then propelling a reentry package in the spacecraft back into the atmosphere at a velocity of about 13 km/sec. A special fuse wire (constructed of aluminum alloy with a palladium alloy jacket) which functions by an alloying reaction with no flame and gives off no smoke or gaseous products was a key element in the design of a heat shield ejection system for the flight experiment. Two such systems were commanded to function on each of two flights in Project Fire, and in all four cases they functioned properly. S.C.W.

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N68-33620 Cornell Univ., Ithaca, N. Y.
TORSIONAL-FLEXURAL BUCKLING OF THIN-WALLED OPEN SECTIONS UNDER ECCENTRIC AXIAL LOADING
Teoman Bekir Pekoz (Ph.D. Thesis) 1967 219 p
Available from Univ. Microfilms: HC $9.90/Microfilm $3.00 Order No. 67-12627

Consideration is given to the behavior of thin-walled open sections under eccentric axial loading with the emphasis on the case of loading in the plane of symmetry for singly symmetric sections. General differential equations of equilibrium are solved for deflection components using the Galerkin method. Conclusions regarding the modes of behavior depending on the nature of eccentricities are drawn from a study of the deflection components. It is seen that a number of modes of behavior are possible; some of them continuous of the beam-column type, some discontinuous of the bifurcation type; some purely flexural, some purely torsional, and some torsional-flexural. Results indicate that the small deflections theory with proper modification regarding the precritical deflections is quite satisfactory. Dissert. Abstr.

N68-33621 Polytechnic Inst. of Brooklyn, N. Y.
NON-PERIODIC VIBRATIONS OF LAYERED VISCOELASTIC PLATES
Irving Wendell Jones (Ph.D. Thesis) 1967 82 p
Available from Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-13398

Consideration is given to the damping of nonperiodic transverse motion in a rectangular elastic plate to which a layer of viscoelastic material has been bonded. A theory is provided in which the damping is linear, but not otherwise restricted in magnitude or time dependence, and in which a single equation of motion, rather than a system of equations, is employed. A system of two simultaneous equations of motion for a perfectly elastic plate is developed; from these a single equation in the transverse displacement variable are derived. The natural boundary conditions are also derived, and an approximate expression is obtained for the neutral plane location. Viscoelasticity relationships are developed to describe the behavior of the damping layer. The viscoelasticity relationships are incorporated into the elastic plate equation to give the governing differential equation of motion for the damped plate. Finally, the equation is solved by Fourier series and Laplace transforms with boundary conditions of simple support. Dissert. Abstr.

N68-33630 Cornell Univ., Ithaca, N. Y.
ON THE AXISYMMETRIC VIBRATIONS OF ORTHOTROPIC CYLINDRICAL AND CONICAL SHELLS
Nazeer Ahmed (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-13910

This thesis consists of two parts. In the first part, the axisymmetric plane-strain vibrations of a thick-layered orthotropic cylindrical shell are analyzed using a generalized Fourier series technique that allows the determination of the frequencies and vibration modes of the composite shell in terms of those of the individual layers. These vibration modes are used to study the forced vibrations of such a shell subjected to an internal harmonic pressure. Numerical results are presented for a two-layered orthotropic cylindrical shell. The lowest axisymmetric modes of vibration of a truncated, orthotropic conical shell whose thickness varies linearly from its apex are studied in the second part by two different approaches. Numerical results are presented for the different cases studied for selected values of the various parameters entering analysis. Dissert. Abstr.

N68-33658 Colorado Univ., Boulder.
AN INVESTIGATION OF CRACKED REINFORCED PHOTOELASTIC MODELS USING A PHOTOELASTIC INTERFEROMETER
Roy Maxwell Goodwin (Ph.D. Thesis) 1966 223 p
Available from Univ. Microfilms: HC $10.15/Microfilm $3.00 Order No. 67-9983

To accomplish the objective of this investigation, it was necessary to develop a cracking stress criteria which could be used when performing a crack propagation analysis in the model. Five reinforced concrete beams were tested for the purpose of studying crack propagation. To assist in observing the cracks which formed in the beams, plaster of paris, stress-coat, and photostress materials were used individually on the sides of the test beams. It was determined that the beam coated with photostress material provided the most accurate crack patterns for use in developing a cracking stress range. The crack patterns obtained from reinforced concrete beam test 5 were incrementally reproduced in reinforced photoelastic models. The photoelastic modal material used was Columbia Resin (CR-39). The use of these model materials allowed the product np, to be equal for prototype and model. The CR-39 model was slotted for reinforcing, and the bars were bonded to the CR-39 with an epoxy resin. Dissert. Abstr.

N68-33674 Oregon State Univ., Corvallis.
PHOTOMECHANICS OF STRESS TRANSFER MECHANISMS IN COMPOSITE MATERIALS
Walter Eugene Edelman, Jr. (Ph.D. Thesis) 1967 72 p
Available from Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 67-12048

A study of stress transfer near the ends of the whisker in a simulated whisker reinforced composite material was conducted by using photoelastic techniques. The composite material studied was αAl_2O_3 whiskers in an aluminum matrix. The photoelastic models used consisted of a scaled-up macroscopic stiffener embedded in a three-dimensional epoxy matrix. The factors controlled during testing were the stiffener geometry, the ratio of modulus of elasticity of the stiffener to that of the matrix, and matrix thickness with respect to the range of influence of the stiffener. The models were loaded in tension and compression to obtain photoelastic stress patterns. Then these stress patterns were duplicated by locking-in techniques. The models were sliced and analyzed. The normal and shear stress distributions along critical directions and the stress transfer length were determined and compared with the theoretical and experimental results of other investigators. Dissert. Abstr.

N68-33680 Pennsylvania Univ., Philadelphia.
NON-LINEAR DYNAMIC BEHAVIOR OF BUCKLED CIRCULAR PLATES
Jameel Ahmad (Ph.D. Thesis) 1967 142 p
Available from Univ. Microfilms: HC $6.80/Microfilms $3.00 Order No. 67-12722

A mathematical solution of the problem of the post-buckling response of a thin elastic circular plate under the action of time dependent axisymmetric radial thrusts is presented. The plate is assumed to remain elastic throughout the post-buckling range. The problem is formulated to include inertial effects by an extension of von Karman's nonlinear theory for the bending of thin plates. The resulting equations are a pair of coupled nonlinear partial differential equations for which an analytical solution is investigated in terms of a Fourier–Bessel series. Circular plates with two types of boundary conditions are considered; plates simply supported at the edge and plates clamped at the edge. The post-buckling responses of the plates under particular types of loading histories are presented. Static solutions are obtained as particular cases of the dynamic analysis and the results are compared with the available static solutions of an earlier work. Dissert. Abstr.

N68-33733 Pennsylvania State Univ., University Park.
ANALYSIS OF WEB-STIFFENED SANDWICH SHELLS UNDER EXTERNAL PRESSURE
Herbert August Peterson (Ph.D. Thesis) 1967 169 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-15411)

An analytical procedure is presented for the determination of deflections and stresses in an externally pressurized, axisymmetric, web-stiffened sandwich shell having end closures and heavy frames. Numerical examples for several web-stiffened sandwich shell configurations have been solved. Experimental tests on photoelastic shells were also conducted. A new technique for constructing photoelastic models of web-stiffened sandwich shells from a cold-setting epoxy plastic was developed and used. In the analytical procedure the shell was subdivided into an outer and inner thin cylinder and a series of annular webs. Concentrated forces and moments were applied at the juncture locations to maintain equilibrium. These redundant loads were determined by imposing conditions of continuity at the junctures. The deflections and stresses were determined from thin shell equations. Dissert. Abstr.

N68-33737*# Southampton Univ. (England). Inst. of Sound and Vibration Research.
THE RESPONSE OF A SIMPLY SUPPORTED PLATE TO TRANSIENT FORCES. PART 1: THE EFFECT OF N-WAVES AT NORMAL INCIDENCE
Anthony Craggs Washington NASA Sep. 1968 34 p refs
(Grant NGR-52-025-003)
(NASA-CR-1175) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A numerical method is presented for determining the response of a structure to transient forces of arbitrary form. It is used to evaluate the response of a simply supported plate to an 'n' wave at normal incidence. Three response parameters are considered: the displacement, the acceleration and the stress at a particular point on the plate. It is shown that the fundamental mode dominates the displacement and stress responses in all cases. However, there is a significant contribution from the higher modes in the accelerations. The maximum response occurs when the duration of the wave is equal to the fundamental period of the plate. Author

N68-33738*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN EXPERIMENTAL AND ANALYTICAL VIBRATION STUDY OF THIN CYLINDRICAL SHELLS WITH AND WITHOUT LONGITUDINAL STIFFENERS
John L. Sewall and Eugene C. Naumann Washington Sep. 1968 56 p refs
(NASA-TN-D-4705) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Aluminum alloy cylindrical shells with and without external or internal integral longitudinal stiffeners for four end-support conditions were investigated. The stiffeners were of rectangular cross section and were closely spaced over the shell surface. Analytical results were obtained by application of the energy method employing the Rayleigh–Ritz procedure, in which longitudinal modal components were approximated by an arbitrary number of elementary beam-vibration functions chosen to satisfy prescribed end conditions. Results show the minimum frequencies of the externally stiffened shell, in all cases, to be significantly higher than the minimum frequencies of the corresponding internally stiffened shells. Agreement between measured and calculated frequencies was significantly improved when the analysis included local transverse bending stiffness due to the stiffeners, and additional beam modes for support conditions other than simply supported. The effect of including stiffener rotatory inertia in the analysis was found to be negligible. Applications of the analysis to two ring-stiffened shells are included to show the extent to which the averaged-stiffener assumption is valid for these configurations. Author

N68-33754 California Univ., Davis.
THERMALLY GENERATED STRESS WAVES IN A DISPERSIVE ELASTIC ROD
Charles Mark Percival (Ph.D. Thesis) 1967 102 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-14985

The propagation of thermally generated stress waves in a dispersive elastic rod is investigated both experimentally and analytically. In the experimental investigation, the end of a circular colored glass rod is heated very rapidly by the deposition of luminous energy from a Q-switched ruby laser. The light from the laser is directed parallel to the axis of the rod and deposited on the polished end of the rod. The absorptivity of the glass for light emitted by the laser is such that the depth of penetration is of the same order as the radius of the rod. The length of the energy pulse from the laser is 20 nsec (i.e., 20×10^{-9} sec). This results in heating at such a rate that it can be considered as instantaneous when compared to the mechanical response of the material used. The resulting stress wave is measured using a thin quartz crystal in a Hopkinson pressure bar arrangement. The experimental results are in good agreement with the theory. Dissert. Abstr.

N68-33786 Joint British Committee for Stress Analysis, London (England).
RECENT ADVANCES IN STRESS ANALYSIS: NEW CONCEPTS AND TECHNIQUES AND THEIR PRACTICAL APPLICATION
[1968] 244 p refs Conf. held 26–29 Mar. 1968
CFSTI: $3.00

Twenty-six conference papers are presented on recent advances in stress analysis techniques and their practical applications. For individual titles see N68-33786 to N68-33812. M.W.R.

N68-33787 College of Aeronautics, Cranfield (England).
THE SEQUENTIAL DESIGN OF REDUNDANT ELASTIC STRUCTURES
D. M. Richards *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 8 p refs (See N68-33786 21-32)

A notation is introduced that permits the visualization of the sequential design process and the description of potentially redundant elastic structure. Preliminary investigation indicates that if a redundant configuration is successively analyzed and redesigned, the design will converge to the lightest statically determinate combination within the original configuration. When more than one optimum substructure exists, the final design will be redundant yet fully stressed. It is noted that the method of repeated redesign is not necessarily desirable as a direct means of structure optimization because the convergence is often time consuming and may require many cycles. It is shown, however, that the redesign sequence always improves the design; and in the two-dimensional case, the rate of improvement is proportional to the volume gradient. When the volume gradient is zero, the design is considered optimum. Some design trajectories related to structure volume, strain energy, and magnitude distribution are included. Both the two and three dimensional structures are treated. M.W.R.

N68-33788 Lagos Univ. (Nigeria).
PROPAGATION OF ERRORS AND TOLERANCE ANALYSIS IN ENGINEERING DESIGN AND STRESS ANALYSIS PROBLEMS
A. B. O. Soboyejo *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p refs (See N68-33786 21-32)

Techniques are presented for determining tolerance limits for engineering assembly components and for estimating errors that are often encountered in engineering and stress analysis problems. Actual estimation of the uncertainty intervals depends largely on judgment as well as experience in real situations. Error and uncertainty sources and their distributions are considered, and the method for representing the random variables is presented. Details are then included for applications in both engineering design and stress analysis problems. For the former, expressions are evolved for the prediction of tolerance of the overall assembly and its components, and a general example indicates how the prediction of errors and uncertainties may be attacked. Errors are classified as those due to (1) incorrect assumptions in the derivation of the basic stress analysis and design expressions and (2) limitations of the measuring apparatus itself. Practical stress analysis problems treated are the hoop stress in a glass wrapped rocket chamber and the creep rupture in pressure vessels. M.W.R.

N68-33789 Royal Aeronautical Society, London (England).
EXPLOITING COMPUTER PROGRAMS FOR DESIGN DATA
R. L. Penning and C. E. Turner (Imperial Coll. of Sci. and Tech.) *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 7 p refs (See N68-33786 21-32)

Computerized efforts for the design of structural members are considered in terms of the complexity, reliability, and availability of already developed programs. Thirteen programs for the elastic analysis of shells of revolution under axisymmetric loading are summarized that include variations for thick vessels, temperature, and loading. The economics of developing new programs is treated, and the establishing of a special group to make computer programs directly available to interested parties is suggested. Efforts of a pilot scheme underway are noted. M.W.R.

N68-33790 Rolls-Royce, Ltd., Derby (England)
A STIFFNESS MATRIX FOR A CURVED MEMBRANE SHELL
J. Barlow *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 4 p refs (See N68-33786 21-32)

Some problems in the discrete element representation of cylinders with widely spaced circumferential stiffeners are outlined. A curved membrane shell idealisation is detailed which overcomes some of the disavantages of more common idealizations and which enables a discrete element representation to be made in the displacement method with a relatively small number of nodal variables. Author

N68-33791 London Univ. (England).
CYLINDRICAL PRESSURE VESSELS WITH FLAT-END CLOSURES
E. I. Hay (Foster Wheeler John Brown Boilers, Ltd.) and R. W. T. Preater *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 9 p refs (See N68-33786 21-32)

A computer program for the stress analysis of cylindrical vessels with flat ends was found to give as accurate, if not better, results than existing solutions or data charts, particularly in the cases of diameter to wall thickness ratios between 5 and 20. A thin shell theory approach was combined with experimental data for such wall thicknesses and for head thickness to wall thickness ratios between 0.7 to 4.0. The theoretical data from the computer output were compared with some photoelastic model experimental values as well as with some results for steel vessels with reduced joint stiffness and stress concentration. Applications are discussed for some newly designed charts that give maximum stresses for these cylindrical vessels. M.W.R.

N68-33792 Southampton Univ. (England). Dept. of Civil Engineering.
PRACTICAL APPLICATION OF A COMPUTERISED STRUCTURAL ANALYSIS SYSTEM WHICH ADOPTS A FINITE ELEMENT TECHNIQUE (DIRECT STIFFNESS METHOD)
John Robinson *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 12 p refs (See N68-33786 21-32)

The analysis of aircraft structures by a computerized system which uses a direct stiffness finite element technique is considered. Structural idealization, the transformation of the actual structure into a practical model, is discussed in general terms and for the case of an aircraft wing. Attention is given to the numbering of nodal points that designate junction, load application, or any other points where information is required; and the choice of finite elements for an idealization is treated. Preparation of the nodal point data for computer input is described, as are the preparation of structural component data, applied loading data, and job cards. Accuracy in data preparation is stressed; and in the case of the wing used as an example, the computerized stress analysis had 1018 structural elements and 675 nodes including those generated inside the computer. The design engineer established 295 nodes. M.W.R.

N68-33793 London Univ. (England). Dept. of Civil Engineering.
TIME-DEPENDENT STRESSES IN CREEP-ELASTIC MATERIALS — A GENERAL METHOD OF CALCULATION
G. L. England *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 8 p refs (See N68-33786 21-32)

The determination of stresses in materials which exhibit time-dependent strain behavior is discussed with particular reference to concrete structures. Theory is presented for the calculation of

time-dependent stresses in creep-elastic materials and two examples are included where the transient stresses in heated concrete beams are evaluated using the theory in the form of an optimization procedure. The drift of the transient stresses towards the steady state of stress is readily apparent in these examples. Based on a specific thermal creep concept, concrete behavior is shown to approximate that of a non-homogeneous Maxwell material when temperatures are not uniform. Concrete may thus be regarded as a pseudo-visco-elastic material. It is concluded that the theory designated the complementary power theory, provides a direct method of estimating transient stresses in heated concrete structures and avoids the repetitive calculations which characterize the historical analyses used previously. Author

N68-33794 Bath Univ. of Technology (England). School of Engineering.
CREEP BUCKLING OF AIRCRAFT COMPRESSION STRUCTURE
S. Butler *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p (See N68-33786 21-32)

Conditions are studied in which creep buckling can lead to a reduction of strength of an aircraft compression structure. The effects of initial eccentricity and the mode of loading are considered relative to the mode of operation of a supersonic aircraft. While various theoretical methods of analysis were studied the main conclusions are drawn from the results of experimental work. The test work included creep buckling tests on various aluminium designs. However, the use of plastic materials for creep buckling test has been proved to have experimental advantages to cost less. Curves giving limiting boundaries to operating conditions of compression structure are included. Author

N68-33795 Bath Univ. of Technology (England).
CREEP OF FABRICATED STRUCTURES
J. W. L. Warren *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 12 p refs (See N68-33786 21-32)

Bending creep tests were performed under constant load at a temperature of 150°C for 1000 hr on 8-ft long box beams, and continuous deflection and local strain measurements were taken. These tests were followed by residual bending strength tests, and data obtained were compared with a step-wise finite element structural analysis based on material and joint creep data. Variability in box beam fabrication and various joint deformation effects prevented the accurate prediction of local creep strains. Since the joint deformation effects also prevented accurate examination of creep deflections, it was concluded that the conventional boom/shear panel idealization used was unsatisfactory in the creep regime even though elastic behavior verified this idealization. Residual strength studies resulted in the recommendation that incipient creep rupture be considered as a design criterion, even at slight overall creep strains. Details are included for elastic, creep, and residual strength theoretical predictions along with the actual results from testing these same properties; and graphs illustrate the correlation between the two types of data. M.W.R.

N68-33796 Aeronautical Research Council (Gt. Brit.).
THERMAL STRESS AND NON-STEADY CREEP
P. W. H. Howe *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 12 p refs (See N68-33786 21-32)

The criteria of thermal strain, strain-hardening theory, and heat transfer coefficients are not considered adequate for dealing with thermal fatigue, nonsteady loading and heat transfer to fluid flow. Thermal fatigue endurances were determined from thermal stresses, obtained by balancing elastic strain rates and creep relaxation, and from mechanical cyclic loading data with triangular waveforms. Closer correspondence between the thermal stress path and mechanical loading requires tests based on segmental paths which generalize triangular waveforms. The recovery of strain during nonsteady loading is expressed in a formula which generalized strain-hardening theory to include a memory effect. Analysis of the formula is simplified provided the memory effect is small, the segmental paths are mathematically orthogonal, and the rate of change of the dominant power in the stress-dependence of creep strain is segmentally linear. The powers of stress and time which correlate experimental creep results were reproduced in a model which assesses by orthogonal function theory the relative effects of the maxima of local stress fluctuations, causing creep and the average of the fluctuations transmitting elastic stress. A heat flow analogy of the creep curve is given by conduction combined with heat transfer to a fluid flow. This treatment of heat flow has a thermodynamic basis, common to the analysis of material behavior and the formulas for heat transfer to a fluid flow are similar to the generalized strain-hardening formula with memory effect. An improvement of the creep model to include stress waves is suggested by the non-proximity to equilibrium of heat transfer. Author

N68-33797 English Electric Co., Ltd., Whetstone (England).
FULLY AUTOMATIC STRUCTURAL ANALYSIS BY THE MATRIX FORCE METHOD
J. R. Stoker *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p refs (See N68-33786 21-32)

Automatic load path determination was investigated for structural analysis by the matrix force method, and an example is included of a pin-jointed triangulated plane frame for which an incidence matrix is used for a path tracing algorithm to establish 23 minimum length first order loops. Finding the load paths in this plane frame was a purely topological problem based on the means in which the members were connected together; although in many three-dimensional problems, member geometry must be accounted for. Methods used for data preparation by the matrix method are noted, and present efforts to provide an equilibrium analysis which is general but does not require large computer storage capacity are described. Details on the preliminary program are included, with efforts underway to make results applicable to any type of structure. An example of the equilibrium analysis applied to a panel structure is included. M.W.R.

N68-33798 English Electric Co., Ltd., Whetsone (England).
THE STRESS ANALYSIS OF AXISYMMETRIC SHELLS USING A PLANE FRAME ANALYSIS PROGRAM
A. Scholes and E. M. Strover *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 7 p refs (See N68-33786 21-32)

A technique presented for the stress analysis of axisymmetric shells subjected to axisymmetric loading permits the development of a stiffness matrix for a conical shell element that is very similar to that of a beam elastically restrained as to its radial and rotational movements. This permits the use of a plane frame program for analysis of the shell, and results in good agreement with other experimental data. Only when the shell approached the axis of symmetry were the results significantly different from thin shell analyses; and while deflections in this region were not effected, stress resultants were less accurate. Derivation of the stiffness matrix is detailed, as is the actual use of the plane frame program; and the cylinder, circular plate, bellows convolutions, and torispherical shell are used as examples to illustrate the program. M.W.R.

N68-33799 Marconi Co., Ltd., Chelmsford (England). Mechanical Engineering Labs.
A FINITE ELEMENT ANALYSIS OF AN EXPANDED I-SECTION BEAM AND AN AXI-SYMMETRIC FLANGED CYLINDER
A. T. Humphrey and V. K. Sunley *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 10 p refs (See N68-33786 21-32)

The finite element method is used to determine the stress distribution and deflected shapes of an expanded I-section beam subjected to bending and an axisymmetric flanged cylinder subjected to axial and bolt pre-tension loads. Factors involved in deciding on a suitable structural idealization are discussed. Author

N68-33800 Royal Aircraft Establishment, Farnborough (England).
A RELAXATION PROCEDURE FOR COMPUTING STRESSES IN BUILT-UP STRUCTURES
E. C. Capey *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 11 p refs (See N68-33786 21-32)

A method is presented for computing the stress distribution in a thin-walled structure by dividing the structure into finite elements, setting up plane stress equations for each element, and solving these by an iterative procedure. Its merits are simplicity of application and economy at computer storage space and operation time. The method is applied to a simple plane stress problem and to a built-up structure. Accuracy is tested by comparing results for the plane stress problem with the known closed form solution, and by comparing results for the built-up structure using different element sizes. Author

N68-33801 University Coll. of Wales, Aberystwyth. Dept. of Civil Engineering.
THE ISOPARAMETRIC FINITE ELEMENT SYSTEM — A NEW CONCEPT IN FINITE ELEMENT ANALYSIS
B. M. Irons *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p refs (See N68-33786 21-32)

The use of isoparametric finite element analysis for the solution of linear elastic stress analysis problems via computerized simulations is considered in terms of improving element characteristics and, thereby, improving the input for the programs used. An overview of the progress made in this area is presented, and some applications of the results are included. Steps involved in finite element formulation are delineated, including the determination of shape function of the parent element as well as the curvilinear element resulting from developing a closer representation of boundaries. Some examples are included for two and three dimensional stress analysis programs. M.W.R.

N68-33802 Birmingham Univ. (England). Dept. of Civil Engineering.
THE DYNAMIC RELAXATION METHOD USED FOR STRESS ANALYSIS
K. R. Rushton *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p refs (See N68-33786 21-32)

The dynamic relaxation method of solving the finite difference form of the equations governing various stress analysis problems is discussed. The plane stress problem of the tensile loading of a flat plate containing grooves is studied which requires the use of graded nets and the representation of curved boundaries. In addition, the determination of the critical damping factor and optimum time increment is discussed. The dynamic relaxation formulation of other stress analysis problems is outlined. Author

N68-33803 Strathclyde Univ., Glasgow (Scotland).
AN ANALYSIS FOR TWIN SADDLE SUPPORTED UNSTIFFENED CYLINDRICAL VESSELS
P. D. Forbes (Natl. Eng. Lab., Glasgow) and A. S. Tooth *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 13 p refs (See N68-33786 21-32)

An historical review as well as experimental results are presented for twin saddle supported unstiffened cylindrical vessels; and an analytical approach, designated the influence area method, for predicting stresses is included. The governing differential equations are given, along with the double Fourier series representation for loading conditions. The influence area concept is shown to permit determination of total displacement at a specific point and the evolution of general expression for radial loading. This form of loading produces no distortion in the cylinder other than a uniform growth of the radius of curvature. Stress resultants and displacements are found by modifying the Fourier coefficients of loading and summing the series over the required range. Also discussed are the saddle/cylinder interface pressure, radial and tangential displacements, and the stress resultants. M.W.R.

N68-33804 Southampton Univ. (England). Inst. of Sound and Vibration Research.
USE AND APPLICATION OF A DIGITAL DATA ANALYSIS SYSTEM
C. A. Mercer *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p refs (See N68-33786 21-32)

Use of an on-line digital computer as an "assistant" in performing an experiment and analyzing the digital data is described. Digital implementation is discussed in general and in relation to the specific case of the acquisition and analysis of random noise and vibration data on a Marconi Myriad II digital computer with a 16K core and 2 million word exchangeable disk unit. Digital sampling and calculating for vibration analyses are reviewed, and possible use of a digital system in vibration and associated studies is noted. Both advantages and limitations of the digital computer system as a research aid in experimental work are considered. M.W.R.

N68-33805 University Coll., London (England).
THE ANALYSIS OF PHOTOELASTIC DATA FOR STRESS SEPARATIONS
I. M. Allison and R. H. Blakemore *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 6 p refs (See N68-33786 21-32)

Time and expertise required by the photoelastic method of evaluating the stress or strain distributions at points within two- or three-dimensional bodies subjected to elastic deformations have deterred engineers from undertaking comprehensive investigations which would be of real value in designing structural components of complex geometric shape. Modifications are discussed to the generally accepted procedures for performing stress separations. Although the adoption of these can result in increased accuracy, with savings in both observation time and operator fatigue, they do nothing to alleviate the volume of standard data processing which forms a considerable part of any photoelastic analysis. A description is given of a method which avoids the performance of lengthy manual calculations by obtaining photoelastic data in a form suitable for processing in a digital computer. This technique has proved to be particularly useful when performing stress separations over large volumes of material. An example of a particular application is given and the accuracy of the results obtained by the proposed method are compared with those derived by more conventional procedures. Author

N68-33806 Boeing Co., Seattle, Wash. Scientific Research Labs.
ON THE EFFECT OF ROTATION OF SECONDARY PRINCIPAL AXES IN SCATTERED LIGHT PHOTOELASTICITY
Y. F. Cheng *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 5 p refs (See N68-33786 21-32)

The effect of rotation of the secondary principal axes (directions of the secondary principal stresses) on the phenomena of double refraction is one of the most important problems in scattered light photoelastic stress analysis. Earlier investigators have concluded that there is a change in fringe order upon rotation. Consequently, fringe gradient cannot be determined with accuracy. So far, three-dimensional problems solved in scattered light are limited to special cases where no rotation occurs. A dual-observation method was developed in which the secondary principal axes and the fringe order are determined from the intensity of scattered light along two

selected directions of observation, and a study was made of the rotational effect on this method. Expressions for intensities of scattered light were derived. It is concluded that the rotational effect can be minimized but not be eliminated. Author

N68-33807 Jobin and Yvon, Arcueil (France).
NEW METHODS IN THREE-DIMENSIONAL AND BI-DIMENSIONAL PHOTOELASTICITY
Andre Robert *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 8 p refs (See N68-33786 21-32)

Main properties of the Poincare sphere, which represents the birefringent behavior of materials are summarized; and photoelastic technique for the quantitative measurements of elliptically polarized light is presented. After discussing the representation of a linear and a circular retarder, the action of a series of linear retarders on a polarized vibration is described. A three-dimensional photoelasticity bench and its industrial realization are discussed, as are the operational principles of an automatic two-dimensional photoelasticity bench. Determination of axes and change in phase as well as the influence of the thickness of the incident beam are considered for the three-dimensional bench; and a test using scattered light on a polymethacrylate specimen is mentioned.
M.W.R.

N68-33808 Technical Univ. of Denmark, Lyngby. Structural Research Lab.
PRODUCTION AND APPLICATION OF MODEL MATERIALS WITH DESIRED PHYSICAL CONSTANTS
Vagn Askegaard *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 8 p refs (See N68-33786 21-32)

Problems related to the production of linear elastic isotropic materials with predetermined properties are considered for use in model tests. Two component materials have been produced from Araldite B (CT200) and air. The combination of these components provides a family of materials in which the modulus of elasticity and Poisson's ratio vary with the air content. The physical constants measured are in reasonable agreement with values calculated by Budiansky expressions. The materials have the same mutual thermal expansion and the "freezing" properties known in three-dimensional photoelasticity. However, the air-entrained materials are opaque at the freezing temperature. Poisson's ratio is approximately 0.50 for the pure Araldite B, and 0.39 for a mixture with 34% air (by volume). This means that the state of stress in the latter material can be determined by measuring the state of strain, and the frozen 3-d state of strain at points of a simple model is measured on a 1/1000 mm dial gauge. The same technique is used on a composite model. Author

N68-33809 Nottingham Univ. (England).
A MATERIAL FOR ACCELERATED CREEP TESTING WITH MODELS
H. Fessler, P. A. T. Gill, and P. Stanley *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 10 p refs (See N68-33786 21-32)

Because of the necessarily extended time-scale involved, experimental confirmation of the design of a structure against excessive creep deformation is not practicable. It is possible, in principle, to predict the long-term deformations of a structure from the short-term, room temperature creep deformations of a model if the model material conforms to certain conditions. These conditions, based on the creep properties of the structural material, provide acceptance criteria against which a number of low melting point metals and alloys were assessed as possible model materials. The main conditions imposed were in respect of grain size, stress index in the primary creep law, similarity of tensile and compressive creep behaviour, and specimen aging effects. A worked lead alloy containing 0.2% antimony and 0.02% arsenic was selected as a model material. The creep characteristics of this material, both in the form of rolled plate and extruded tube, were determined from constant load, uniaxial tensile tests. For the extruded tube, this work included a limited investigation of the degree of anisotropy and inhomogeneity. "Stepped load" uniaxial tensile creep tests were used to assess the suitability of a time or strain hardening creep hypothesis for this model material. Author

N68-33810 Edinburgh Univ. (Scotland). Dept. of Civil Engineering.
APPLICATION OF GENERALISED STRAIN-MEASURE TO SIMPLE DEFORMATION PROBLEMS IN THE FIELD OF PLASTICITY
R. Royles, T. C. Hsu (Univ. of Aston) and S. R. Davies *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 8 p refs (See N68-33786 21-32)

The concept of generalised strain-measure is explained and applied to the linearization of basic stress-strain curves of compressive, shear, and tensile nature. Some light is thrown on the phenomenon of stress saturation, and the applicability of generalized strain to simple one-dimensional deformation processes is discussed. Author

N68-33811 University Coll. of Swansea (Wales).
APPLICATIONS OF THE TELECENTRIC PRINCIPAL IN OPTICAL STRAIN MEASUREMENTS
A. Luxmoore *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 5 p refs (See N68-33786 21-32)

A telecentric lens system was used to make grid recordings for strain measurement problems. Combined with the moiré technique, such a lens system can use the diffraction effects inherent in grids to improve fringe sharpness, contrast, and the accuracy of the strain measurements. Application of profile projectors in engineering metrology as optical comparators is discussed, and it is noted that the large field profile projectors do not provide a convenient portable unit for a telecentric camera system. Applications of the telecentric lens combined with the moiré technique are then considered, and diffraction effects of moire' grids are discussed in detail. A double aperture system to be used for such optical strain measurements is under investigation. M.W.R.

N68-33812 Royal Aircraft Establishment Farnborough (England).
A PRELIMINARY STUDY OF THE CREEP AND RECOVERY BEHAVIOUR OF DTD 5070A ALUMINIUM ALLOY
D. A. Berry and R. F. W. Anstee *In* Joint Brit. Comm. for Stress Analysis Recent Advan. in Stress Analysis [1968] 14 p refs (See N68-33786 21-32)

Some preliminary results are presented in relation to the accumulation of creep in DTD 5070A aluminum alloy subjected to a time varying stress, and a method of creep recovery was developed that can be used to determine the growth of the anelastic strain or the recoverable component of creep strain. Test results also indicate a relationship between the plastic strain, or the component of creep strain that is not recoverable, and the anelastic strain. The recovery behavior was found to follow a consistent behavior pattern, whereas the behavior on load was shown to be strongly dependent upon the previous stress history; and these differences in behavior are considered to suggest two different mechanisms of deformation in the material. Marked effect of the length of the recovery period on the subsequent creep behavior was indicated by the test results, and this is related to the remaining anelastic strain in the material when the reloading starts. A secondary rate effect, possible due to total time at temperature, was shown when the material was loaded to 17.3 kg/mm^2 although it did not appear at 11.0 kg/mm^2. M.W.R.

N68-33817 Auburn Univ., Ala.
SECOND ORDER ELASTICITY THEORY APPLIED TO A CIRCULAR CYLINDER UNDER TWIST AND SIMULTANEOUS EXTENSION

James Chie-Meng Yu (Ph.D. Thesis) 1967 122 p
Available from Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-12524

Cauchy's hypothesis that the stress tensor is a function of the strain tensor is used to develop a general second order constitutive equation for all elastic materials, from which the pressure effects on classical elastic moduli are studied. The boundary value problem in second order elasticity is developed and exemplified by a circular cylinder under twist and simultaneous extension, for which the stresses and displacements are given explicitly. The Poynting effect and the effect of axial elongation upon torsional stiffness are studied. The general equations for the determination of the second order elastic moduli are given. Numerical values of second order elastic moduli of steel and copper are calculated, based on both Poynting's and Foux's experiments. Dissert. Abstr.

N68-33831 Colorado Univ., Boulder.
EFFECTS OF ANISOTROPY IN SHELL PROBLEMS
Suresh Thakordas Gulati (Ph.D. Thesis) 1967 73 p
Available from Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 67-15029

The solution of an axisymmetric anisotropic circular dylindrical shell subjected to normal surface load is obtained with the aid of Laplace transformation. The shell material is assumed to possess elastic symmetry with respect to the middle surface of the shell. The analysis presented in this investigation is based on a theory deduced recently by Naghdi and accounts for the effects of the transverse shear deformation. The shear deformation and the classical theory solutions for the case when the shell material is orthotropic are also obtained. Some of the effects of anisotropy as apparent from these solutions are discussed. By way of a specific example involving an edge loaded circular cylindrical shell, the anisotropic effects and their coupling with the effects of the transverse shear deformation are brought out quantitatively through a consideration of the displacements and stresses in the cases when the shell material is anisotropic and orthotropic. Dissert. Abstr.

N68-33841# National Aeronautical Establishment, Ottawa (Ontario).
THE ELASTIC SUSPENSION OF A RIGID BODY
E. Kosko Jan. 1968 66 p refs
(NRC-10121; NRC-MS-118) CFSTI: HC $3.00/MF $0.65

Methods are presented for the statical analysis of elastic suspension systems that include extensional springs with linear characteristics. The elastic properties of such a suspension are formulated in terms of a matrix of stiffness coefficients. Formulas for these coefficients are derived for an arbitrary three-dimensional arrangement of springs, and also for various special configurations possessing one, two, or three special planes or axes, called principal elastic planes or axes. Some misconceptions arising from a mistaken analogy between systems of masses and systems of springs are clarified. It is shown that the latter possess principal planes or axes only in special cases, including cases of plane or axial symmetry. These special cases are discussed in detail. Application of the method is illustrated by two numerical examples. Author

N68-33842# National Aeronautical Establishment, Ottawa (Ontario).
A FINITE CYLINDRICAL SHELL ELEMENT AND THE VIBRATIONS OF A CURVED FAN BLADE
Mervyn D. Olson and Garry M. Lindberg Feb. 1968 45 p refs
(NRC-10198; NRC-LR-497) CFSTI: HC $3.00/MF $0.65

The stiffness and mass matrices for a relatively simple finite cylindrical shell element are presented. The element has 28 degrees of freedom corresponding to the seven generalized coordinates $\partial w/\partial x$, $\partial w/\partial y$, w $\partial u/\partial y$, u, $\partial v/\partial y$, and v at each corner. All six rigid body modes for the element are adequately represented by this model. The element is used to predict the vibrations of a curved fan blade, and the results are verified experimentally. It is found that a 4 × 4 grid of the finite elements is sufficient to predict the first 12 vibration frequencies for the fan blade to within 10 percent. The agreement between experimental and theoretical mode shapes is generally very good. Author

N68-33850*# Minnesota Univ., Minneapolis.
BEHAVIOR OF ELASTIC NETWORKS OF VARIOUS DEGREES OF ORIENTATION IN THE KINETIC THEORY OF FRACTURE
H. H. Kausch-Blecken von Schmeling and C. C. Hsiao Apr. 1968 28 p refs
(Grant NGR-24-005-070)
(NASA-CR-96550: TR-113) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A kinetic theory of fracture is described using a network of linear elastic elements as a model to calculate the strength and elastic properties of oriented materials. Emphasis was placed on the questions as to whether the assumptions of small strains as well as the invariant molecular orientation distribution are valid for the total fracture process. During the fracture process the breakage of molecular elements reduces the modulus of elasticity. However, it was found to be less than one percent for most of the lifetime of a sample. Author

N68-33890 Michigan Univ., Ann Arbor.
THE ELASTIC ANALYSIS OF GRILLAGES INCLUDING TORSIONAL EFFECT AND STABILITY
Pin-yu Chang (Ph.D. Thesis) 1967 101 p
Available from Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-15603

The purpose of this dissertation is to investigate the behavior of grillages subjected to normal and axial loads. Since grillages find wide application in the design of many types of strucutres, many methods have been introduced to solve this problem in the literature. However, all the methods published so far are either incomplete or restricted to a special type of grillages. The principle of variational calculus is used to set up the differential equations and the Laplace Transformation is applied to solve the differential equations. For grillages whose torsional rigidity of the members is negligible the differential equations can be uncoupled and a very simple method to calculate the deflection, the bending moment, etc., has been developed. For those grillages where torsional effect of the members is important, the differential equations cannot be uncoupled, in general, and the numerical computations are much more complicated. A program has also been made for this purpose. Dissert. Abstr.

N68-33945 Northwestern Univ., Evanston, Ill.
ON DESTABILIZING EFFECTS ASSOCIATED WITH COMPLEX FORCES IN NONCONSERVATIVE, ONE-DIMENSIONAL, CONTINUOUS SYSTEMS
Shyam Nath Prasad (Ph.D. Thesis) 1967 85 p
Available from Univ. Microfilms: HC $3.40/Microfilm $3.00 Order No. 67-15316

Consideration is given to certain aspects of the theory of stability of continuous one-dimensional, nonconservative elastic systems. In particular, it turns out that several kinds of such systems may be described analytically by the same nonself-adjoint boundary value problem involving a complex differential equation of motion. The imaginary part of the complex force parameter is of special interest because it may be associated with a destabilizing effect, the loss of stability being due primarily to the real part of the complex force. The physical organ of the imaginary part may be associated with velocity-dependent forces, and certain other forces which need not be velocity-dependent. Several general theorems are applied to uncover a number of features governing swept wings in high-density, low-speed flow and pipes conveying fluid. Dissert. Abstr.

N68-33951 Northwestern Univ., Evanston, Ill.
FREE AND FORCED MOTION OF AN ELASTIC PLATE SUPPORTED BY A SEMI-INFINITE CONTINUUM

Satya Prakash Keshava (Ph.D. Thesis) 1967 143 p
Available from Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-15259

Plate equations are used to determine dispersion curves for free waves in a layer and a supporting half-space of difference elastic properties. The approximate dispersion curves are compared with curves obtained by employing elasticity equations for the layer. Both welded and smooth contact between the layer and the half-space are considered. For a relatively soft layer, agreement is good at small wave numbers. For a relatively stiff layer, good agreement is obtained over the whole range of wave numbers for which a free wave can exist. Using plate theories to descrive the motion of the layer the forced motion of the system is studied for the following cases: (1) the forcing agent is a time-harmonic stationary point load, (2) the forcing agent is a concentrated load moving at a uniform velocity on the layer, and (3) the motion in the plate-half-space system is caused by elastic waves traveling in the supporting medium and impinging on the plate. Dissert. Abstr.

N68-34032# Indian Inst. of Science, Bangalore. Dept. of Aeronautical Engineering.
NATURAL FREQUENCIES OF VIBRATION OF ISOTROPIC FLAT PLATES, 1
S. Durvasula, R. N. Burbure, and S. Srinivasan Apr. 1968 39 p refs
(AE-190S) CFSTI: HC $3.00/MF $0.65

In this report, natural frequencies of rectangular and parallelogrammic plates with different combinations of edge conditions such as free, simply supported, clamped and elastically restrained are given. Author

N68-34035# Indian Inst. of Science, Bangalore. Dept. of Aeronautical Engineering.
NATURAL FREQUENCIES AND MODES OF CLAMPED SKEW PLATES
Somayajulu Durvasula Jul. 1968 61 p refs
(AE-219S) CFSTI: HC $3.00/MF $0.65

Natural frequencies and nodal patterns of a wide range of clamped skew plates are obtained using the Galerkin method expressing the deflection in terms of a double series of beam characteristic functions of a clamped-clamped uniform beam. Results are presented in the form of tables and graphs. This study revealed the interesting features like the skew angle splitting the degenerate frequencies of the rectangular plate into distinct frequencies and the frequency crossing of some modes, which belong to opposite symmetry groups, of the skew plates at certain angles of skew. The modal patterns are quite interesting. With changing skew angle, the nodal patterns of some modes undergo a gradual change to other forms. Since, for some modes the diagonals happen to be the nodal lines, such modes can be interpreted as the appropriate modes of the corresponding triangular plates with suitable boundary conditions. Author

N68-34036*# Harvard Univ., Cambridge, Mass.
ON THE SHELL EQUATIONS IN COMPLEX FORM
J. Lyell Sanders, Jr. Aug. 1967 29 p refs Presented at the 2nd Iutam Symp. on the Theory of Thin Shells, Copenhagen, 5–9 Sep. 1967 Submitted for publication
(Grant NsG-559)
(NASA-CR-89179; SM-16) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This paper is concerned with the problem of formulating the general equations of linear thin shell theory in terms of complex combinations of dependent variables in such a way as to arrive at a fourth order system of partial differential equations. Consideration is limited to elastic, isotropic, homogeneous shells with edge loads only. Author

N68-34049*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
A NUMERICAL PROCEDURE FOR CALCULATING STRESS AND DEFORMATION NEAR A SLIT IN A THREE-DIMENSIONAL ELASTIC-PLASTIC SOLID
David J. Ayres Washington 1968 28 p refs Presented at Natl. Symp. on Fracture Mech., Bethlehem, Pa., 17–19 Jun. 1968; Sponsored by Lehigh Univ.
(NASA-TM-X-52440) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This iterative technique, based on Newton's method for determining the roots of a system of polynomials, is applicable to both linear and nonlinear problems. The procedure requires a minimum of computer storage capability and moderate computer running time. Three sample stress-concentration problems are treated. The first problem is the analysis of a plate in plane strain with a slit at its center, the second is the analysis of a thick plate with a rectangular slit through its thickness, and the last is the analysis of a thick plate containing a semielliptical slit which extends only halfway through the thickness. The loading condition in all sample problems is uniaxial tension normal to the slit. Author

N68-34080*# Arizona State Univ., Tempe. Mechanical Engineering Dept.
HEAT TRANSFER BETWEEN SURFACES IN CONTACT: THE EFFECT OF LOW CONDUCTANCE INTERSTITIAL MATERIALS. PARTS 4 AND 5: INVESTIGATION OF THERMAL ISOLATION MATERIALS AND THEIR APPLICATION IN BOLTED FLANGE JOINTS
D. A. Gyorog and P. A. Smuda Aug. 1968 75 p refs
(Grant NGR-03-001-033)
(NASA-CR-73248; ME-TR-033-5, Pts. 4&5) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An overview is presented on the experiments conducted to obtain data on the thermal insulation of contacts with low conductance interstitial materials. Specific emphasis is placed on assessing the results obtained from studies on combinations of materials for multilayer interstitial configurations. Tabulated data are given on interstitial material and bare junction runs in which pyrotex, textolite, TFE teflon sheets, carbon paper, mica, and stainless steel screens were studied. Attention is also focused on two antenna assembly bolted flange joint configurations which were selected to test various promising interstitial insulating materials. B.S.D.

N68-34109#
STRESS STATE OF A HOLLOW SPHERE LOADED BY CONCENTRATED FORCES
A. F. Ulitko [1968] 8 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), v. 4, no. 5, 1968 p 38–45
CFSTI: HC $3.00/MF $0.65

A numerical analysis is made of the stress distribution in a closed spherical shell loaded at the poles by concentrated forces, by starting from the exact solution of this problem as an axisymmetric problem of elasticity theory. Characteristic peculiarities in the stress behavior along both the generator and thickness of the shell, including the zones directly adjacent to the points of application of the concentrated forces, are exposed. Author

N68-34112#
REACTION OF A SUBMERGED CYLINDRICAL SHELL TO A PRESSURE WAVE PROPAGATED AT SUPERSONIC VELOCITY IN THE DIRECTION OF THE GENERATOR
E. N. Mnev [1968] 9 p refs Transl. into ENGLISH from Inzh. Mekh. Tverdogo Tela (USSR), no. 3, 1968 p 119–125
CFSTI: HC $3.00/MF $0.65

The solution for a stationary axisymmetric wave in an infinite circular cylindrical shell submerged in a compressible fluid is considered within the span of the linear theory of interaction with an acoustic medium. The reaction of the shell to a pressure wave of delta and unit step function type propagated in the direction of

the shell axis at a velocity exceeding the speed of sound in the fluid is investigated. Some simplifications of the problem are examined. It is shown, in particular, that upon reducing the three-dimensional problem for the fluid to two-dimensions the additional pressure in the medium caused by the shell deformations should be determined from the Ackeret formula. Formulas are obtained for the profile of a radial shell strain wave. The error in a number of known solutions is pointed out. Author

N68-34113#
ON A METHOD OF SOLVING STABILITY AND VIBRATIONS PROBLEMS OF ELASTIC SYSTEMS WITH VARIABLE PARAMETERS
V. F. Natushkin [1968] 9 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), v. 4, no. 5, 1968 p 93–100
CFSTI: HC $3.00/MF $0.65

It is shown that in some particular cases an influence function of the elastic deflection can be constructed for elastic systems with relatively slighty changing geometric and loading parameters, and the solution of the problem can be reduced to considering a linear integral equation of Fredholm type with symmetric kernel. The method is illustrated by solving the problem of axial compression of a shell of revolution of nonzero Gaussian curvature. Author

N68-34135*# Drexel Inst. of Tech., Philadelphia, Pa. Wave Propagation Research Center.
ANALYSIS OF TRANSIENT STRUCTURAL RESPONSE BY THE METHOD OF CHARACTERISTICS
Pei Chi Chou Jul. 1968 29 p refs
(Grant NGR-30-004-013)
(NASA-CR-66691; DIT-340-1) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A brief summary of a unified approach to the transient response of structures obtained by the method of characteristics is presented. Comments are made on the types of governing partial differential equations, the stability in numerical calculation, the extrapolation technique, and the relation between continuous and discrete systems. The merits and limitations of the method of characteristics are compared with other methods. Author

N68-34201*# Michigan Univ., Ann Arbor.
ENGINEERING ESTIMATES FOR SUPERSONIC FLUTTER OF CURVED SHELL SEGMENTS
William J. Anderson and Kuo-Hsiung Hsu [1967] 26 p refs Presented at the AIAA/ASME 9th Struct., Structural Dyn. and Mater. Conf., 1 Apr. 1968
(Grant NGR-23-005-166)
(NASA-CR-89185) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Static aerodynamic theory is used to find design curves for the flutter of curved panels. The panels are rectangular segments cut from a circular cylindrical shell. Supersonic flow is directed parallel to the generators of the shell segment. The pressure expression used is general enough to encompass a wide range of physically possible pressure distributions. Design curves are given in the form of a thickness parameter required to prevent flutter as a function of curvature and length-to-width ratio. Upper and lower bounds for the onset of coupled-mode panel flutter are given. Comparisons with other theories and experiments are made. The results are intended to aid in design of wind tunnel models for panel flutter tests. Author

N68-34285*# California Univ., Berkeley. Structural Engineering Lab.
STATIC AND DYNAMIC ANALYSIS OF SANDWICH SHELLS WITH VISCOELASTIC DAMPING
John F. Abel and E. P. Popov Aug. 1968 299 p refs
(Grant NsG-274)
(NASA-CR-96738; SESM-68-9) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The finite element technique is extended to the refined analysis of multilayer beams, plates and shells with no restriction placed upon the ratios of the layer thicknesses and properties. The method is applicable to structures wherein shearing deformations are significant, including sandwich type structures. Element stiffnesses developed are based on polynomial displacement models and are for the linear elastic analysis of beams, circular plates, and thin, axisymmetric shells of arbitrary meridian. Although stiffnesses derived are for three layered construction with similar facings, the proposed theory is applicable to any flexural elements and to any arrangement of laminations, provided the total thickness is moderate. Here, doubly curved elements have been used to represent rotational shells. Computer programs have been written both for static analysis and for free and forced steady state vibration analysis. Inclusion of rotatory as well as translational inertia allows determination of natural thickness shear frequencies and mode shapes in addition to flexural vibration characteristics. Author

N68-34337# Brown Univ., Providence, R. I. Div. of Engineering.
ON THE KINEMATICS OF FINITE ELASTIC-PLASTIC DEFORMATION
L. B. Freund Jun. 1968 26 p refs
(Contract ARPA SD-86)
(AD-672352)

The geometric and kinematic description of the motion of an elastic-plastic body undergoing finite deformation is considered. A configuration distinct from the initial and current configurations of the body is introduced, which is supposed to be the state of the body due to its plastic deformation alone, and also to be the reference configuration for elastic deformation. It is shown that the rate of deformation tensor may then be written as the sum of the rates of elastic and plastic deformation. Restrictions imposed by some physical assumptions are considered, and the form of some of the derived relations is given for two-dimensional deformations in Cartesian and cylindrical coordinates. Author (TAB)

N68-34344*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VIBRATION RESPONSES OF SIMPLE CURVED PANELS TO HIGH-INTENSITY RANDOM AND DISCRETE FREQUENCY NOISE
Carl E. Rucker [1968] 22 p refs Presented at the 39th Shock and Vibration Symp., St. Louis, 1–2 May 1968
(NASA-TM-X-61200) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Unexpectedly short times to failure for curved panels under acoustic loading led to detailed studies of their dynamic response characteristics with the objective of exploring the reasons for such short times to failure. Non-linear response characteristics were observed involving significant low-frequency motions due to buckling. Such behavior resulted in a much higher percentage of large strain amplitudes than would be predicted for a normal strain amplitude distribution. The acquisition of joint strain-sound pressure distributions for significant time durations was greatly facilitated by the use of a pulse height analyzer which digitized, classified, stored, and displayed large amounts of information. Author

N68-34346*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A SINUSOIDAL PULSE TECHNIQUE FOR ENVIRONMENTAL VIBRATION TESTING
James T. Howlett and Dennis J. Martin [1968] 18 p ref Presented at the 39th Shock and Vibration Symp., St. Louis, 1–2 May 1968
(NASA-TM-X-61198) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Many environmental tests are based on shock spectrum and the test specification frequently require a slowly swept sinusoidal input. For this type of test, the input amplitude required to produce a response equivalent to that resulting from a transient is highly dependent upon the damping of the system under test. The procedure which is usually followed is based on a single value of

damping and results in a considerable overtest of low damped systems. This paper proposes a test method which accounts for the variation of response with damping. The test input consists of a spaced sequence of sinusoidal pulses. The frequency, amplitude, and number of cycles of each pulse are selected to adequately meet specified shock spectra for various levels of damping. Application of the method to a realistic test specification indicates a significant improvement over a slow sweep procedures. Author

N68-34361*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELASTIC WAVE PROPAGATION FOR PLANE STRAIN PROBLEMS BY THE THEORY OF CHARACTERISTICS
M. Zv 29 Feb. 1968 36 p refs
(Contract NAS7-100)
(NASA-CR-96768; JPL-TR-32-1308) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A method is presented by which the theory of characteristics is extended to include elastic waves in two-spatial dimensions. This method makes use of Hadamard's work on surfaces of discontinuity in the dependent variables and their derivatives. A model is developed for a surface propagating in a linear elastic, isotropic, and homogeneous medium. Velocities and stresses of the material particles are assumed to be discontinuous in their first partial derivatives across the propagating surface. A transformation is used for this model by which the relevant discontinuity relations from Hadamard's theory are applied to the dynamical field equations. Application of this transformation results in a system of necessary dynamical conditions which then lead to the derivation of the characteristic equations for two-spatial dimensions. Not only are these characteristic equations shown to contain the well known one-spatial dimensional form, but they accommodate more complex cases encountered in one-spatial dimensional wave problems. The derived characteristic equations are applied to the numerical evaluation of two representative boundary-value problems. Author

N68-34422# Army Materials and Mechanics Research Center, Watertown, Mass.
CONSTANT FORCE SPRING
Kenneth D. Robertson Apr. 1968 15 p refs
(AMMRC-TR-68-07; AD-672511)

In many instances a suspension system is required to protect equipment from the combined effects of both shock and vibration. A new nonlinear spring, the vacuum spring, has been developed which may satisfy both shock and vibration requirements simultaneously. This spring combines high energy absorption and vibration attenuation over a wide range of forcing frequencies. This unusual behavior is produced by a stepwise nonlinearity in its loading curve which is composed of two straight-line segments of differing slopes representing two independent spring rates. The slopes of these line segments and the point of intersection can be adjusted to suit any particular design requirements. A spring-mass system involving this concept has been simulated on an analog computer. Results indicate that it is possible to construct a suspension system which will not resonate at any frequency (under certain loading conditions) but will absorb large amounts of energy while remaining elastic. Author (TAB)

N68-34443*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
IDENTIFICATION OF COMPLEX STRUCTURES USING NEAR-RESONANCE TESTING
John P. Raney [1968] 29 p refs Presented at the 38th Shock and Vibration Symp., St. Louis, 1-2 May 1968
(NASA-TM-X-61205) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A recent innovation for determining the set of governing differential equations of motion of a complex structure is described. Numerical values for the mass, stiffness, and damping coefficients of the dynamical equations associated with a particular input-response or transmission path are computed from the data usually obtained in conventional vibration tests of a structure. The theory is based on the dynamic properties of multi-degree-of-freedom linear systems. The method requires the steady response (acceleration, velocity, displacement, or stress) and the driving sinusoidal force input for transmission paths of interest to be experimentally determined for a few frequencies near each major structure resonance. Application of the method is illustrated by determining from experimental data the equations of motion of 1/10- and 1/40-scale models of the Apollo/Saturn 5 launch vehicle. Transient responses, computed using the identified equations for the 1/40-scale model, are shown to agree favorably with experimental results. Author

N68-34547# IIT Research Inst., Chicago, Ill. Dept. of Mechanics.
LARGE PLASTIC DEFORMATION OF THIN SPHERICAL SHELLS WITH REINFORCED OPENINGS
Richard L. Chiapetta and Philip G. Hodge, Jr. Jun. 1968 131 p refs
(Contract Nonr-1406(04))
(DOMIIT-J-38; AD-672049)

The large deformation behavior of a membrane spherical shell subject to internal pressure loading is investigated. The shell contains a hole at the apex which is reinforced by an idealized thin ring. The incremental theory of plasticity is employed, effects of geometry changes and isotropic strain hardening are included and elastic strains are neglected. Solutions for loads up to the tensile instability load are obtained for the Tresca and von Mises yield criteria and associated flow laws. A complete solution in closed form is derived for shells having openings with sufficiently heavy reinforcements for the Tresca criterion. A numerical procedure and associated computer program, based on solution of the rate equations are derived for shells obeying the von Mises yield criterion. The latter procedure is valid for all but very light reinforcements. Numerical results are obtained which provide an indication of the effect of geometrical and material parameters on the instability pressure. The instability pressures for a range of shells are compared to their yield point loads. Comparisons are also made between predictions of the von Mises and Tresca theories and between theoretical and experimental results. Author (TAB)

N68-34557# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
MULTILAYER DAMPING TREATMENTS FOR SKIN-STRINGER STRUCTURES
Donald R. Simmons (M.S. Thesis) Jun. 1968 186 p refs
(GSF/MC/68-9; AD-672244)

A general theory is developed to analyze the damping of an equivalent free layer applied to a continuous skin-stringer structure. A damping parameter, the ratio of energy dissipated in the treatment to the maximum total strain energy in the structure, is derived and theoretical curves presented for 36 configurations as a function of treatment length and number of layers. Experimental values of the damping parameter are also presented for one configuration as a function of the number of layers and experimental values compared to the theoretical predictions. The theoretical predictions are quite good where adequate theoretical normal mode shapes are available. Author (TAB)

N68-34588# IIT Research Inst., Chicago, Ill. Mechanics Dept.
ELASTIC-PLASTIC TORSION OF MULTIPLY-CONNECTED CYLINDERS BY QUADRATIC PROGRAMMING
Carl T. Herakovich and Philip G. Hodge, Jr. Jun. 1968 106 p refs
(Contract Nonr-1406(04))
(DOMIIT-1-37; AD-672047)

A numerical method for solving the problem of elastic/perfectly-plastic torsion of a cylinder of general shape is presented. The method applies finite elements and a minimum rate principle of plasticity to provide a complete history of stress function during a quasi-static, monotonically increasing angle of twist. In particular, the method exhibits the plastic unloading phenomenon which occurs for some hollow cylinders. For the

chosen finite element representation, the minimum principle reduces to a problem in quadratic programming. Results are presented for both simply and multiply-connected cylinders and are compared to other available results. It is shown that for the problems which were analyzed plastic unloading occurs in areas of high stress concentration only after the value of the stress function on the inside boundary has essentially reached its maximum. Author (TAB)

N68-34649# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VIBRATIONS IN TURBOMACHINERY
A. G. Kostyuk Nov. 1967 211 p refs Transl. into ENGLISH of the book "Kolebaniya V Turbomashinakh" Moscow, Moscow Power Engineering Inst., 1961 p 1–214
(FTD-HT-23-527-67; AD-672185)

Contents: Vibration of systems with a single degree of freedom; Vibrations of systems with several degrees of freedom; Critical rotor speeds; Transverse vibrations of a rod; Transverse vibrations of elastic plates. Author (TAB)

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N68-33612 National Lending Library for Science and Technology, Boston Spa (England).
THE TURBULENT COMBUSTION OF GASES
A. S. Sokolik, V. P. Karpov, and E. S. Semenov 9 May 1968 27 p refs Transl. into ENGLISH from Fiz. Goreniya i Vzryva (USSR), no. 1, 1967 p 61–75 *Its* Transl. No. 1142
Available from Natl. Lending Library, Boston Spa, Engl.

Using a new method, experimental studies of turbulent combustion mechanisms of gas mixtures were made over a wide range of artificially produced physical-chemical conditions in a closed vessel (bomb); objectives of these studies were to establish experimental proof of: (1) how the velocities of turbulent and normal flames are related; and (2) the extent to which the observed laws for the velocities of turbulent flame justify the assumed similarity in the mechaniam of flame propagation in turbulent and laminar flames. Studies of ternary mixtures CH_4–O_2–(N_2,Ar,He); a stoichiometric mixture of oxygen with propane, methane, hydrogen diluted with identical quantities of Ar or He; and hydrogen-air flames indicated that the velocity of turbulent combustion is determined not by the velocity of normal flames but by the rate of chemical reaction in the flame. Studies of hydrazine dissociation flames (laminar and turbulent) confirmed the validity of the proposed assumption that turbulent combustion is a pulsating ignition process A method for determining the macrokinetic characteristics on the basis of the effective energy of activation is proposed. Techniques used in the direct determination of the reaction time in micro-volumes in the process of pulsating ignition were demonstrated in studies of ionization in hydrocarbon flames directly connected with chemical transformations. S.C.W.

N68-33626# Atomic Energy Commission Research Establishment, Riso (Denmark). Electronics Dept.
DISTRIBUTED PARAMETER PROBLEM SOLVED ON HYBRID COMPUTER USING A MODIFIED FUNCTION STORAGE TECHNIQUE
N. J. Poulsen Apr. 1968 27 p
(RISO-M-736) CFSTI: HC$3.00/MF$0.65

A simplified approach to the hybrid computer simulation of a Benson vessel is described. The specific physical system adopted in the simulation is a single tube heat exchanger, with mathematical expressions derived for transfer functions. A method for solving first order partial differential equations (PDE) is given. The solution is based on physical equations (specifically two first-order PDE) and accurate within 1% to 2%. Features considered in simulating PDE on hybrid computers are the distributed timing control; HO periods to convert series operation of a digital computer to parallel operation of an analog computer; and interpolation circuits in the integration of an analog computer. B.P.

N68-33628 Arkansas Univ., Fayetteville.
INVESTIGATION OF THE EXTRINSIC FACTORS ASSOCIATED WITH THE TOTAL CONDENSATION OF STEAM WITHIN HORIZONTAL, RECTANGULAR CROSS-SECTION CHANNELS
John Bernard Dressman (Ph.D. Thesis) 1967 113 p
Available from Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 67-12862

This paper presents the results of an investigation of the pressure drop, mass rates, and heat transfer rates associated with saturated steam totally condensing in horizontal, rectangular cross-section channels. Unlike previous investigations of similar phenomena, the approach presented here does not attempt to describe and study the local flow mechanism. Instead, the local heat transfer rates, which essentially determine the local condensation rates, give rise to a distribution factor, ϕ, that accounts for these effects and allows the pressure drop to be expressed in terms of the other variables by equations having the form: $\Delta P = a_1(\phi\rho_{go} V^2_{go} L^{1/2}/2g_c d^{1/2})^2 + a_2(\phi\rho_{go} V^2_{go} L^{1/2}/2g_c d^{1/2})$. Local heat transfer results are also included. The maximum pressure drop encountered during the experiment was 21.2 lb_f/in^2 and the maximum mass rate was 0.0461 lb_m/sec. Dissert. Abstr.

N68-33657 Syracuse Univ., N. Y.
OPTIMAL DESIGN OF EVAPORATOR SYSTEMS BY DYNAMIC PROGRAMMING
Seiji Itahara (Ph.D. Thesis) 1967 148 p
Available from Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 67-12067

Optimal design procedures have been established for several evaporator systems by dynamic programming. The object of the procedures developed is the calculation of the optimal policies which determine the minimum area or minimum annual operating expense for evaporator systems. The exact dynamic programming solution for the minimum heat transfer area in a simple multiple effect system requires two state variables and one decision variable. A simplified iterative procedure has one state variable and one decision variable. An optimization procedure for multiple effect flash evaporator systems is derived. A continuous flash evaporation problem is formulated as an aid to the determination of the cost of the limiting case when the number of effects approaches infinity. Finally, an algorithm to optimize a single effect, multi-stage flash evaporator system is presented. Dissert. Abstr.

N68-33665* Denver Univ., Colo. Dept. of Metallurgy.
THERMODYNAMIC ANALYSIS OF DILUTE TERNARY SYSTEMS. 1. THE Ag–Au–Sn SYSTEM
P. J. Spencer and M. J. Pool [1967] 18 p refs Submitted for publication
(Grant NsG-518)
(NASA-CR-87774) CFSTI: HC$3.00 CSCL 20M

The heats of solution of silver and gold in dilute Ag–Au–Sn alloys were determined as a function of alloy composition using liquid metal solution calorimetry. From the values obtained, the various enthalpy interaction parameters in the liquid solutions were calculated. The results are interpreted in terms of the probable bonding changes taking place between silver, gold, and tin atoms. Author

N68-33668# Aeronautical Research Inst. of Sweden, Stockholm.
ANOMALOUS HEAT TRANSFER AND PRESSURE DISTRIBUTION ON BLUNT BODIES AT HYPERSONIC SPEEDS IN THE PRESENCE OF AN IMPINGING SHOCK
Barry Edney Feb. 1968 92 p refs
(Contract INKS/Br-41748)
(FFA-115) CFSTI: HC $3.00/MF $0.65

An extraneous shock impinging on a blunt body in hypersonic flow is observed to alter the flow around the body and increase both the local heat-transfer rate and pressure near the impingement point. Novel, quasi-static techniques are developed to study this phenomenon. Glass models, equipped with platinum thin-film thermometers, are injected into a hypersonic tunnel through a slot in a variable-incidence flat plate which generates the extraneous shock. Analogue networks provide graphs of the heat-transfer rates at various points on the model as a function of the model's position relative to the extraneous shock. Peaks in local heat-transfer rates up to 10 times the local, unperturbed, free-stream values are recorded as the model traverses the shocks. A similar technique is used to measure the peak pressure. Six different types of interference are shown to exist. The effect of varying the free-stream Mach number, the strength of the impinging shock and the ratio of specific heats on both the peak pressure and the peak heat-transfer rate are also accounted for, in excellent agreement with experiment. Author

N68-33710 Utah Univ., Salt Lake City.
THERMAL EFFECTS OF COMPOSITE-PROPELLANT REACTIONS
Jih Tien Cheng (Ph.D. Thesis) 1967 287 p
Available from Univ. Microfilms: HC $13.05/Microfilm $3.70 Order No. 67-12669

The decomposition reactions of epoxy-cured polybutadiene-acrylic acid copolymer were studied at heating rates from 50 to 150°C per second. Blackened films of material 100 microns thick were bonded to a copper disk, 325 microns thick, which served as a thermojunction to measure the temperature of the film-copper interface, and the free surface was exposed to black body radiation in a tube furnace. The interface temperature and the response of a photocell viewing the polymer surface were recorded, then interpreted to determine the events occurring at the heated surface. Weight loss measurements were also made. Both simple polymer and polymer mixed with burning rate catalysts, ammonium perchlorate and glass beads were studied. The ranges of experimental conditions were: furnace temperature, 800 to 1100°C; gaseous environment, oxygen and nitrogen; pressure, vacuum to 5 atmospheres. Dissert. Abstr.

N68-33713 Rice Univ., Houston, Tex.
CONDENSATION OF A DIELECTRIC VAPOR IN THE PRESENCE OF A NONUNIFORM ELECTRIC FIELD
Ronald Edwin Holmes (Ph.D. Thesis) 1967 108 p
Available from Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-13084

A thorough investigation of the dielectric vapor in the presence of a non-uniform electric field is undertaken. Equations predicting the rate of heat transfer under these circumstances are derived. The validity of these equations is then verified by conducting several experimental runs, condensing Freon 114 in the presence of a non-uniform alternating electric field. Included is a comprehensive survey of work on the subject of heat transfer in the presence of an electric field, the forces developed in a fluid when an electric field is applied, and the changes in fluid properties which may occur in the presence of an electric field. Dissert. Abstr.

N68-33741 Wisconsin Univ., Madison.
HEAT TRANSFER IN TURBULENT FLOW, INCLUDING THE EFFECTS OF A REVERSIBLE CHEMICAL REACTION
Eric Kenneth Johnson (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 67-6802

The purpose of this investigation is to develop a general approach to heat transfer in turbulent flow. To attain this goal, a new approach to the mixing length concept was formulated. This approach, combined with Jenkins' heat eddy diffusivity model, produced a relationship for any Prandtl number. This relationship is within reasonable agreement with experimental data for fluids with Prandtl numbers between 0.02 and 7.5. The relationships developed from the new mixing length approach are then applied to the problem of turbulent forced convection heat transfer in a pipe. The predicted heat transfer parameters agree with the experimental data for fluids whose Prandtl numbers are in the range from 0.02 to 1.0. Jenkins' heat eddy diffusivity model was then extended to include the effect of a reversible, near equilibrium, chemical reaction. The basic heat transfer equation for turbulent reacting flow was then reformulated to conform to the new heat eddy diffusivity. Dissert. Abstr.

N68-33775 Pennsylvania Univ., Philadelphia.
THE CONDUCTIVITY OF MERCURY VAPOR AT HIGH TEMPERATURES AND PRESSURES
Edgar Watson, Jr. (Ph.D. Thesis) 1967 214 p
Available from Univ. Microfilms: HC $9.70/Microfilm $3.00 Order No. 67-12814

This study was undertaken to obtain accurate conductivity data for mercury vapor as a function of temperature and density and to provide a better understanding of the physical properties of the metal vapor system. Using this information it was hoped that a conduction process could be established, and any changes in the electrical properties as the density of the vapor was increased could be determined. A fused quartz conductance cell fitted with molybdenum electrodes was used in these experiments. It was placed in an internally heat pressure vessel, and the vapor pressure of mercury was compensated by an external pressure of argon. Accurate temperature and conductivity measurements were made at various vapor densities. Dissert. Abstr.

N68-33822# National Research Council of Canada, Ottawa (Ontario).
EXPLORATORY STUDY OF THE INITIATION OF LOW-DENSITY PETN BY HYDROGEN–OXYGEN DETONATION WAVES
A. H. Makomaski Feb. 1968 73 p refs
(NRC-10122; NRC-MT-59) CFSTI: HC $3.00/MF $0.65

This Report is a study of the problem of initiation of low-density PETN by impact of plane hydrogen–oxygen detonation waves in a tube of constant cross-sectional area. The charges were either pressings of pure crystals (of needle-form or finely ground) or explosive-impregnated foams. Ionization probes and a steak camera were used to study the process of initiation as well as the shock waves generated on detonation of the explosive. Author

N68-33862 Florida Univ., Gainesville.
THERMODYNAMIC PROPERTIES OF SOLID HELIUM
Gerald Clarence Straty (Ph.D. Thesis) 1966 143 p
Available from Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-13165

Using a capacitance type strain gage, the PVT properties of solid He^3 have been investigated. Measurements of pressure as a function of temperature on constant volume samples, for molar volumes of 17.65 to 24.70 cm^3/mole, have been made for temperatures from 0.35°K to the melting curve. The isothermal compressibilities were computed by graphical differentiation of the isotherms and were found to be almost independent of temperature. Isobaric thermal expansion coefficients have been obtained by graphical differentiation of the isochores and were found to be appreciable only in the vicinity of the melting curve, decreasing

rapidly at lower temperatures. No negative thermal expansion for the solid above 0.35°K was observed. Evidence is presented which indicates the possible existence of a negative thermal expansion below the temperature of the melting curve minimum. Dissert. Abstr.

N68-33947# Israel Inst. of Tech., Haifa.
TURBULENT SWIRLING JET DIFFUSION FLAMES
Amnon Chervinsky [1968] 45 p refs
(TAE-87) CFSTI: HC$3.00/MF$0.65

The phenomenological boundary layer equations of a jet diffusion flame with swirl are solved in the von Mises plane. The expressions are compared with experimental results for a number of jet flames with different degrees of swirl, employing the flame surface model. A method for calculating turbulent exchange coefficients in the flame is presented and used to derive flame length. The results show that by increasing the amount of swirl in the flame an increase of the width of the flame and mass entrainment and a corresponding decrease of flame length are achieved. These variations are associated with the increased turbulent eddy viscosity and the variation of the turbulent Prandtl number in the flame due to increased swirl. Author

N68-33959# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HEAT AND MASS TRANSFER
29 Sep. 1967 24 p refs Transl. into ENGLISH from Teplo i Massoperenos (Minsk), v. 4, 1966 p 183–190, 273–278
(FTD-MT-24-248-67; AD-671873)

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N68-33960# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE STRUCTURE OF SURFACE OF BURNING OF MODEL MIXTURES OF SOLID FUELS [ISSLEDOVANIYE STRUKTURY POVERKHNOSTI GORENIYA MODEL'NYKH SMESEVYKH TVERDYKH TOPLIV]
P. F. Pokhil and L. D. Romodanova *In its* Heat and Mass Transfer 29 Sep. 1967 p 1–8 refs (See N68-33959 21-33)

A study was made of the surface structure of burning solid propellants containing $KClO_4$, NH_4ClO_4, or $NaClO_4$ as oxidizers and tungsten, graphite, naphthaline, starch, or succinic or malonic acid as fuels. The surface structure was studied by means of a microscope with 10–80x magnification. The study showed that in a mixture of a nonmelting oxidizer (NH_4ClO_4) with a melting or decomposing fuel, the NH_4ClO_4 crystals protrude above the surface at pressures lower than 30 atm abs. At pressures exceeding 30 atm abs indentations were observed at the points where the protrusions had been located at a lower pressure. Thermally stable fuels such as graphite and tungsten tend to concentrate on the surface. When evaporation or decomposition temperature of the oxidizer is higher than that of the fuel (napthaline), the concentration of the oxidizer on the surface increases. In the oxidizer or fuel melt on the propellant surface, small bubbles generated by the decomposition of the fuel and oxidizer and by liquid-phase oxidation of the fuel were observed. The pressure limit of a NH_4ClO_4-fuel mixture below which the fuel does not undergo stable combustion depends on the particle size of the NH_4ClO_4 and the physical properties of the fuel. Author

N68-33961# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE DISTURBANCE OF NORMAL CONDITIONS OF THE BURNING OF POROUS CHARGES OF EXPLOSIVE SUBSTANCES [O NARUSHENII NORMAL'NOGO REZHIMA GORENIYA PORISTYKHA ZARYADOV VZRYVCHATYKH VESHCHESTV]
V. K. Bobolev, I. A. Karpukhin, and S. V. Chuiko *In its* Heat and Mass Transfer 29 Sep. 1967 p 9–14 refs (See N68-33959 21-33)

The development of combustion instability and the deflagration to detonation transition was studied in a constant volume bomb by pressure recording and high speed photography. The hexogen samples were compacted into plexiglass cases and ignited by an electric wire or a powder charge. The results showed that the deflagration to detonation transition under increasing pressure takes place according to the following order: normal combustion; perturbed combustion; ejection of particles into the flame zone, which is accompanied by interruption of luminosity; accelerated combustion of the ejected particles, which generates a pressure increase above the burning surface; and gas penetration into the pores, which leads, in case of a pure explosive, to a detonation and, in case of an explosive phlegmatized with paraffin wax, to accelerated combustion of the charge. Phlegmatization of the charge decelerates the development of this process and eliminates the deflagration to detonation transition. A new type of deflagration to detonation transition was found which is caused by the self-ignition of semiproducts and gases in the pores of the charge. Author

N68-33965# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
QUANTUM MECHANICAL EQUATION OF STATE OF A HARD-SPHERE GAS AT HIGH TEMPERATURE
B. Jancovici Aug. 1968 8 p refs
(Rept.-68/25) CFSTI: HC$3.00/MF$0.65

At high temperature, the quantum effects in the equation of a gas are small and appear as corrections. In the special case of a hard-sphere gas, these corrections cannot be obtained by Wigner and Kirkwood's expansion in powers of $\hbar^2$, the terms of which diverge ($\hbar$ is Planck's constant divided by 2π). An expansion in powers of $\hbar$ is possible and described. The quantum mechanical free energy of a hard-sphere gas at high temperature is a series in powers of the thermal wave length; the coefficients of this series can be expressed in terms of the classical correlation functions. Author

N68-33998*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBUSTION OF HYDROGEN AND METHANE TO SIMULATE EXPANSION OF STORABLE PROPELLANTS
Robert Friedman, Raymond E. Gaugler, and Erwin A. Lezberg Washington 1968 19 p refs Presented at the 4th Propulsion Joint Specialist Conf., Cleveland, 10–14 Jun. 1968; sponsored by AIAA
(NASA-TM-X-52434) CFSTI: HC$3.00/MF$0.65 CSCL 21B

An experimental investigation of exhaust-nozzle temperatures for the storable system 50% UDMH-50% hydrazine/nitrogen tetroxide was conducted using hydrogen and methane fuel burned in oxygen-enriched air to provide the same atomic constituents as the storable propellants. Oxidant-fuel mass ratios of 1.6 to 2.5 at 3.7 atm combustion-chamber pressure were simulated by control of the fuel, oxygen, and air flows; inlet enthalpies were duplicated by preheating the oxidant in a pebble-bed storage heater. Static temperatures, measured by a spectral line reversal pyrometer at 5 stations in the expanding portion of a 5.5-area-ratio Mach 3 nozzle, were found to be nearly insensitive to oxidant-fuel ratio and close to temperatures calculated for a frozen expansion. This study demonstrated the feasibility of the simulation technique for exhaust-nozzle kinetic studies. Results agreed well with a simplified

kinetic analysis based on a "sudden freezing" of the nozzle recombination reactions at an area ratio of 1.04 upstream of the throat. Author

N68-33999 Case Inst. of Tech., Cleveland, Ohio.
RADIAL TIME FUNCTIONS AND OTHER SOLUTIONS OF RADIAL HEAT EQUATION
Richard Anthony Kowalski (Ph.D. Thesis) 1967 92 p
Available from Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-16083

The functions V_ω and U_β are solutions of the radial heat equation for $\mu = \omega$ and $\mu = \beta$ respectively. An expansion theory for solutions of the equation $D^2_r u(r,t) = D_t u(r,t)$, has been developed where $u(r,0+) = 0$, $u(0,t) = f(t)$. The function U_β has the property that $U_\beta(r,0+,f) = 0$, $U_\beta(0,t,f) = f(t)$. Expansion theorems, analogous to the above, are developed for the function U_β. The solution U_β is represented in terms of the set of radial time functions. Theorems are developed which relate the asymptotic behavior of U_β and the time average of U_β to behavior of the function f(t) and its Laplace transform. Similar theorems are obtained for the function V_ω. Several sets of special solutions which have been used in expansion theories for the radial heat equation are examined. It is proved that the radial time functions and the elements of these several sets have a common form, involving confluent hypergeometric functions. Dissert. Abstr.

N68-34030 Michigan Univ., Ann Arbor.
TRANSPORT PHENOMENA IN THE BINARY AIR-ABLATION PRODUCT LAMINAR BOUNDARY LAYER AT THE STAGNATION POINT OF RE-ENTRY VEHICLES
Robert Sylvester Scullen (Ph.D. Thesis) 1967 292 p
Available from Univ. Microfilms: HC $13.30/Microfilm $3.75 Order No. 67-15691

The basic purpose of this thesis is to study the laminar boundary layer over an ablating surface. The heat transfer-mass transfer relationship at the wall is included in the analysis. The thermal diffusion and radiation effects are also included. The study is intended to provide a better understanding of the characteristics of boundary layer flow over ablating surfaces and, in particular, of the significance of the thermal diffusion and radiation effects. The model chosen for this study is a binary mixture composed of the hot free stream and the ablation product flowing over body geometries that permit similarity solution. The free stream (air) is allowed to dissociate in order to maintain itself in a state of thermochemical equilibrium, although it is still treated as a single species in the binary mixture model. Dissert. Abstr.

N68-34034# Indian Inst. of Science, Bangalore. Dept. of Aeronautical Engineering.
THE THEORY OF BURNING OF A MONOPROPELLANT DROPLET: VARIABLE PROPERTIES
N. Ramani and V. K. Jain Dec. 1966 30 p refs
(AE-166A) CFSTI: HC $3.00/MF $0.65

The theory of burning a monopropellant droplet is studied taking into account the variation of properties. Numerical and Analytical solutions have been obtained for Step function and Adams type reaction rate functions respectively. It is shown that the assumption of constant properties, underestimates the burning rate for a given chemical decomposition parameter. It is further shown that the thin flame approximation overestimates the burning rate; however, the error decreases as the chemical decomposition parameter increases. Author

N68-34071# Aeronautical Research Council (Gt. Brit.)
BIBLIOGRAPHY OF HEAT-TRANSFER INSTRUMENTATION
F. J. Bayley and A. B. Turner London HMSO 1968 60 p
(ARC-R&M-3512) CFSTI: HC $3.00/MF $0.65

About 100 references are given relevant to heat fluxmeters, thermocouples, surface temperature measurements, kinetic heating, radiation measurement, application of phase change methods and uses of resistance thermometers. ESRO

N68-34076*# Oak Ridge National Lab., Tenn. Reactor Div.
A PRELIMINARY COLLATION OF THE THERMODYNAMIC AND TRANSPORT PROPERTIES OF POTASSIUM
H. W. Hoffman and B. Cox Jul. 1968 124 p refs
(NASA Order W-12353; Contract W-7405-ENG-26)
(NASA-CR-96741; ORNL-TM-2126) CFSTI: HC $3.00/MF $0.65 CSCL 20M

This memorandum compiles data on the properties of potassium in the saturated-liquid and saturated- and superheated-vapor states and is intended to provide a convenient and consistent data source for those engaged in the design and evaluation of power systems based on thermodynamic cycles using potassium as the working fluid. Included are (1) the nuclear properties—cross section to thermal neutrons, natural isotopic abundance, radionuclide decay characteristics, and neutron interactions, (2) the thermodynamic properties—physical constants, critical state conditions, sonic velocities, PVT relationships (equation of state, vapor pressure, density, and compressibility), enthalpy, latent heat of vaporization, heat capacity, entropy, and surface conductivity, and electrical resistivity. The data are presented both in tabular form and in graphical form. A preliminary and limited evaluation of the data is attempted; and while the situation is somewhat better than for the cesium properties, there is an indicated need for additional measurements of some properties. Author

N68-34088*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF BOILING ON A FIN
Y. Y. Hsu Washington Sep. 1968 23 p refs
(NASA-TN-D-4797) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A simplified method of calculation is proposed to determine the performance of a fin exposed to various modes of boiling. The heat-transfer coefficients of boiling were approximated by segments of simple n^{th} power functions of superheat. These functions provide the analytical solution of the temperature gradient in the fin as a function of temperature. Results compare favorably with those obtained from a small-increment numerical solution. Three examples are given to illustrate the application of fin concept to boiling heat-transfer processes. Author

N68-34090# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Strahlantriebe.
TEMPERATURE RISE IN WIND TUNNELS FOR POWER PLANTS [TEMPERATURANLAUFERSCHEINUNGEN IN TRIEBWERKSWINDKANAELEN]
E. Riester 29 Apr. 1968 56 p refs In GERMAN; ENGLISH summary
(DLR-FB-68-30) CFSTI: HC $3.00/MF $0.65

Investigations are made concerning temperature rise in wind tunnels for power plants after starting the tunnel run. Literature data for heat transfer are supplemented by some further measurements. With the results of the measurements the influence of heat flux on temperature distribution is calculated for main components of a tunnel. Author (ESRO)

N68-34111#
SOLUTION OF THE SYSTEM OF MOTION EQUATIONS OF A SELECTIVELY RADIATING GAS IN THE SHOCK LAYER
N. A. Anfimov and V. I. Shari [1968] 11 p refs Transl. into ENGLISH from Izv. An SSSR, Mekh. Zhidk. i Gaza (USSR), no. 3, 1968 p 18-25
CFSTI: HC $3.00/MF $0.65

Numerical solutions are obtained for the system of integrodifferential equations describing the flow of a viscous, heat-conducting, selectively radiating gas in the region between the

shock and the blunt body. The computations are for bodies of 0.1 to 3 m radius with a 6000 to 15000°K stagnation temperature. Convective and radiative heat fluxes in the neighborhood of the stagnation point are obtained. The influence of blowing on convective and radiative heat exchange is investigated. Author

N68-34243 Oklahoma Univ., Norman.
RADIATIVE HEAT TRANSFER FROM A FINITE CYLINDRICAL PARTICLE CLOUD
Leo Warren Stockham (Ph.D. Thesis) 1967 170 p
Available from Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 67-15905

The problem of radiative heat transfer from a metalized propellant rocket exhaust is of current concern to the aerospace industry. The problem involves the transfer of thermal radiation from an axisymmetric dispersion of metallic oxide particles and includes the effects of absorption, emission, and anisotropic scattering. The present work differs from previous works in that all of the above mentioned effects are included in the analysis. Specifically this work considers thermal radiation to the base region of a finite cylindrical cloud of absorbing, emitting and anisotropically scattering particles. A Monte Carlo model of the problem is developed which permits the radiation to originate either within the cloud or from a black circular surface at the base of the cloud. The emitted photon (bundle of energy) is then followed through a series of probable paths until it leaves the cloud and hits or misses the base plane. Dissert. Abstr.

N68-34287*# Purdue Univ., Lafayette, Ind. Jet Propulsion Center.
AN EXPERIMENTAL INVESTIGATION OF THE HYPERGOLIC IGNITION OF SOME POLYMERIC FUELS WITH OXYGEN
S. D. Kershner, J. R. Osborn, and A. M. Mellor Jul. 1968 148 p refs Sponsored in part by Thiokol Chem. Corp. Prepared in cooperation with Purdue Research Foundation
(Grant NsG-592)
(NASA-CR-96715; JPC-447; TM-68-5) CFSTI: HC $3.00/MF $0.65 CSCL 21B

This report presents the results of an experimental investigation of three polymeric fuels with oxygen at temperatures of about 260 to 320°C and within a pressure range of 8.8 to 20.6 atmospheres. The polymeric fuels were carboxy terminated polybutadiene (CTPB), polybutadiene acrylic acid (PBAA), and polystyrene (PS). The investigation consisted of two parts: a determination of the ignition time of the polymers as a function of oxygen concentration and temperature and a determination of the mass spectra of the pyrolysis products of these polymers in equilibrium with one atmosphere of helium at 260°C. Ignitions were obtained for all three polymers; listed in the order of decreasing ease of ignitability they are PBAA, CTPB, and PS. The ignition times for the PBAA and CTPB polymers exhibited a low order dependence on oxidizer concentration and a strong dependence on initial temperature. The mass spectral results indicated that the maximum mole fraction of fuel vapors present under any ignition conditions was less than about two per cent. Author

N68-34425# Michigan Univ., Ann Arbor. Gas Dynamics Labs.
THE STRUCTURE AND KINETICS OF THE H_2-CO-O_2 DETONATIONS
Pai-Lien Lu, E. K. Dabora, and J. A. Nicholls Jun. 1968 144 p refs
(Contract DA-31-124-ARO(D)-299)
(Rept.-06996-2-T; AROD-5209-3-E; AD-672521)

The characteristics of self-sustained detonation waves propagating in H2-CO-O2 mixtures was experimentally investigated. Two major, independent techniques were employed; the side relief method and pulsed laser schlieren photography. The experimental results from both techniques show that the reaction zone thickness increases slowly at first as CO replaces H2 in H2-O2 mixtures. The laser schlieren data show that the reaction zone thickness increases exponentially with CO concentration after the CO exceeds about 75% of the total fuel. A simple relationship between the reaction zone thickness and the hydrogen concentration in the mixture was found. The chemical kinetic scheme in H2-CO-O2 mixtures was investigated by studying the quenching of detonations by the side relief technique and with interpretation by an explosion limit criteria. The results rule out the kinetic scheme involving ozone as proposed by Lewis and von Elbe. The Minkoff and Tipper scheme, which involved the formation of HCO, shows slightly better agreement with the results than that proposed by Buckler and Norrish. Author (TAB)

N68-34435*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ORDERLY THREE-DIMENSIONAL PROCESSES IN TURBULENT BOUNDARY LAYERS ON ABLATING BODIES
Thomas N. Canning, Michael E. Tauber, Max E. Wilkins, and Gary T. Chapman [1968] 13 p refs Presented at the AGARD Spec. Meeting on Hypersonic Boundary Layers and Flow Fields, 1-3 May, 1968, London
(NASA-TM-X-61188) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Contrary to the frequently made assumption of random behavior, careful experimental studies reported in the literature have revealed a remarkable degree of order in transitional and turbulent boundary layers. Some results are reported here of tests made with biconic, concave, and convex ablating Plexiglas models in a Mach 7 airstream with maximum local Reynolds numbers approaching 10^7. After they were tested, the model surfaces were carefully examined. In addition to such well-known features as turbulence wedges and streamwise grooves, produced by longitudinal vortices, many parts of the models exhibited a "cross-hatching" pattern which had also been previously observed by the authors under other conditions. It was found that the spiral angle of the cross-hatching is close to the Mach angle based on boundary-layer-edge Mach number while the spacing is typically equal to a few boundary-layer thicknesses. A physical flow model is outlined which could explain the cross-hatching and other observed patterns. Author

N68-34455# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
DERIVATION OF THE BOLTZMANN EQUATION AS A TEST OF KINETIC-THEORETICAL SCHEMES
Toyoki Koga Mar. 1968 48 p refs
(Contract Nonr-839(38); ARPA Order 529; Proj. Defender)
(PIBAL-68-7; AD-672329)

The derivation of the Boltzmann equation from the Liouville equation can be a means of testing the feasibility of a kinetic-theoretical scheme, since the Boltzmann equation is known as empirically plausible. From this viewpoint, one investigates kinetic-theoretical schemes deriving the Boltzmann equation. One may derive the Boltzmann equation consistently by considering the Liouville equation to govern the distribution of a system in the phase space which is not symmetric in the microscopic sense. On the other hand, one cannot derive the equation consistently on the assumption of symmetry of the distribution; the Boltzmann collision integral is not compatible with the symmetry assumption. Author (TAB)

N68-34584*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THERMAL DESIGN OF INFLATABLE SPHERICAL SHADOW SHIELDS
D. G. Mc Connell and J. P. Campbell [1968] 26 p refs Presented at the Aviation and Space Conf. sponsored by ASME, Los Angeles, 16-19 Jun. 1968
(NASA-TM-X-61243) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Heat transfer from a spherical balloon type shadow shield to a spherical cryogen storage tank under space conditions is

discussed. The analysis covers the design factors of combined skin conductance and internal radiation for the shield; high emittance bands on the inside and outside of the shield; optimum width of these bands; and temperature varying absorptance and emittance of the shield's surface. The following results were obtained: (1) The high emittance bands and temperature varying emittance combine to lower shield temperatures significantly. Banding allows more heat loss to space. Temperature varying emittance narrows the spread in temperature in going from the sun side to the shadow side of the shield; and it lowers the shield temperature level. (2) Joint inside and outside banding is much more effective than outside banding alone. Optimum inside and outside banding reduces boil-off heat flux by a factor of 4. Outside banding alone gives at most a 12% reduction. (3) Optimum high emittance band width is a weak function of shield–tank separation. The optimum band width is 15° at a separation of one tank diameter, (tank and shield diameter are the same in this analysis). Author

N68-34609# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STEADY STATE HEAT TRANSFER THROUGH A WALL WITH LONGITUDINAL RECTANGULAR FINS AND A VARIABLE COEFFICIENT OF THERMAL CONDUCTIVITY [STATSIONARNAYA TEPLOPEREDACHA CHEREZ STENKU OREBRENNUYU PRODOLNYMI PRYAMOUGOLNYMI REMBRAMI, PRI PEREMENNOM KOEFFITIENTE]

D. A. Kosarev Aug. 1967 11 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (Moscow), v. 9 no. 6, 1965 p 788–792
(FTD-HT-67-178; AD-672285)

The solution of the stationary problems of heat transfer is usually derived with the assumption that the heat conductivity coefficient is independent of the temperature. For relatively low temperature differences this assumption leads to small errors only; for large temperature differences (600-1000K), however, the error may be substantial. The paper presents a graphic-analytic method of the solution of the heat-transfer problem through surfaces ribbed by longitudinal, rectangular ribs, taking into account the variable coefficient of the heat conductivity of the material. An example is worked out demonstrating the feasibility of solving the heat transfer problem taking into account the temperature-dependence of the material heat conductivity. Author (TAB)

N68-34715# Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.

SELF-CONSISTENT SOLUTION OF NONLINEAR PROBLEMS IN UNSTEADY RADIATION GASDYNAMICS

David Finkleman Sep. 1967 379 p refs
(Contract AF 49(638)-1621)
(MIT-DSR-76052; AFOSR-67-2454; TR-147; AD-672278)

It is shown that the system of equations which governs the unsteady flow of a radiating gas in chemical nonequilibrium is hyperbolic, and standard methods are applied to the solution of situations in radiation gasdynamics (RGD) which are restricted neither in optical depth nor the radiation-convection parameter. Absorption of shock layer radiation by the upstream gas is included in a numerical method of characteristics, and it is proved that only a Mark-type radiation boundary condition is appropriate to the lowest order full-range differential approximation of one-dimensional radiative fields. To illustrate the method, the flow fields generated by planar and cylindrical pistons inserted into ideal gases with arbitrary absorption properties are investigated both with the differential approximation and the full transfer equation. The results obtained are believed to be the first in a realistic aerodynamic situation and show that the differential approximation predicts surface pressures and heat transfer rates very accurately and general flow fields within ten percent for the cases considered. It was found that linearized theories of piston insertions may be in error near the start of motion. In addition, nonmonotonic (entropy layer induced) surface pressure histories were noted, and it is observed that variable surface emissivity and wall temperature may exert blowing or suction upon entropy layers. Upstream absorption is shown to be a dominant mechanism in the evolution of unsteady flow fields, and contrary to previous predictions it is shown that the effects of radiation upon pressure and velocity may be comparable to those upon temperature in many cases. Author (TAB)

N68-34754*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

CONVECTIVE STAGNATION-POINT HEAT TRANSFER IN PARTIALLY EQUILIBRIUM FLOW OF HIGHLY IONIZED NITROGEN

Arthur F. Okuno and Chul Park [1968] 17 p refs Presented at the Heat Transfer and Fluid Mech. Conf., Seattle, 17–19 Jun. 1968
(NASA-TM-X-61187) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Measurements of stagnation-point heat-transfer rate in a nitrogen stream at high ionization levels were made in a continuously operated arc-heated wind tunnel. The stream was thought to be frozen for molecular dissociation and in equilibrium for ionization in the boundary layer, and an analysis was made of this partially equilibrium flow. The results of both theory and experiment show that when the flow is partially in equilibrium, the total heat-transfer rate is appreciably lower than would be predicted by previous theories. The new theory provides a lower limit on heat-transfer rate attainable by a noncatalytic surface in the ionized regime. Author

N68-34760# Purdue Univ., Lafayette, Ind. Project Squid Headquarters.

SOLUTIONS OF BOLTZMANN EQUATION AND TRANSPORT PROCESSES

Rashmi C. Desai (MIT) and John Ross (MIT) Jun. 1968 42 p refs Supported in part by NSF Prepared in cooperation with MIT
(Contract N00014-67-A-0226)
(SQUID-TR-MIT-43-PU; AD-672195)

An Integral Approximation (IA) method is proposed for the solution of certain integro-differential equations of which the linearized Boltzmann equation is one example. The lowest order solution in this method consists of replacing the integral operator of the equation by a known function such that the solution has the correct initial value, correct initial slope in time and correct behavior at large times. The deviation of the integral operator from the function is treated as a perturbation in higher orders. The method is applied as an example to the calculation of the time correlation functions and thermal transport coefficients. Deviations from the exponential behavior of the correlation functions are explicitly evaluated. Another method of solution which involves a cumulant expansion (CU) is also used for the evaluation of these quantities. Both methods are then compared with the Chapman-Enskog (CE) method. The IA method provides a better physical approximation and better numerical estimates for the thermal transport coefficients than the CU or CE method. Author (TAB)

N68-34795# Aerojet-General Corp., San Ramon, Calif. Nuclear Div.

ALKALI METALS EVALUATION PROGRAM Quarterly Progress Report, 1 Jan.–31 Mar. 1968

P. Y. Achener 7 Jun. 1968 19 p refs
(Contract AT(04-3)-368)
(AGN-8284) CFSTI: HC $3.00/MF $0.65

Brief studies of the following are presented: (1) determination of the Prandtl number of gaseous cesium and rubidium; (2) surface tension and contact angle measurements on lithium with oxygen impurities; and (3) research on the thermodynamic and transport properties of alkali metals. NSA

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N68-33768*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
REDUCTION TO PRACTICE OF SPACE INVENTIONS
Robert F. Kempf [1967] 4 p Presented at the 5th Space Cong., Cocoa Beach, Fla., 11–14 Mar. 1968
(NASA-TM-X-60468) CFSTI: HC $3.00/MF $0.65 CSCL 05D

The legal concept of actual reduction to practice is considered in relation to the case where successful operation of the invention must be performed in outer space. Consideration is given to the extent of territorial sovereignty in the airspace above a nation's boundaries, and operation of an invention above a foreign country or above the high seas. Two approaches are proposed as a basis for finding a reduction to practice in the United States. M.G.J.

N68-34084# European Space Research Organization, Paris (France).
SPACE DOCUMENTATION SERVICE
J. R. U. Page and N. E. C. Isotta *In its* ESRO Bull. No. 2, 1967 p 10–12 (See N68-34081 21-30)

The aims and operation of the ESRO Space Documentation Service (SDS) are explained and future expansion according to increasing requirements outlined. ESRO

N68-34387*# Stanford Research Inst., Menlo Park, Calif.
SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 5. ECONOMIC IMPACTS
Roger W. Hough Jun. 1968 59 p refs *Its* Aerospace Systems Ser. v. 5
(Contract NASw-1722; SRI Proj. MU-7227)
(NASA-CR-96809) CFSTI: HC $3.00/MF $0.65 CSCL 05C

NASA activities are considered to have a positive influence on many southern localities in which space research and development centers and production, testing, and launch facilities have been established. Because of the highly paid and highly educated personnel associated with research facilities, the quality of education and other aspects of community life have been improved. In addition, the rise in per capita income in these areas has improved overall productivity; and in certain instances NASA has served as a catalyst in stimulating other business developments. The south as a region is discussed, along with the NASA Manned Space Flight communities. Identifiable NASA contributions to Huntsville, Alabama; Brevard County, Florida; New Orleans and nearby Mississippi; and Houston, Texas, are discussed in terms of population growth, school enrollment and facilities, residential and building permits, personal income per capita, and retail sales. Other impacts in each of these areas as a result of increased productivity are noted. M.W.R.

N68-34388*# Stanford Research Inst., Menlo Park, Calif.
SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 4: IMPACTS OF NEW MATERIALS TECHNOLOGY
Arthur E. Bayce Jun. 1968 63 p refs
(Contract NASw-1722; SRI Proj. MU-7227)
(NASA-CR-96813) CFSTI: HC $3.00/MF $0.65 CSCL 05C

Contributions of NASA to selected areas of materials technology and the resulting impact on the national economy were investigated through a literature search technique. All entries in STAR (Scientific and Technical Aerospace Reports) dealing with 33 selected materials areas were obtained for the period between 1962 and 1967. Technology areas that had a significant percentage of NASA reports were studied, namely electroforming; fuel cells; nickel-cadmium, silver-cadmium, and silver-zinc batteries; refractory alloys; solar cells; and stress corrosion of titanium alloys. All eight areas were considered to have impact on the power generation; all but refractory and titanium alloy research on communications; and all but silver-cadmium battery and solar cell research on transportation. Electroforming, nickel-cadmium batteries, and titanium alloys were found to have impact on health care. It was concluded that the battery, refractory alloy, and titanium alloy development had major impact; fuel cell research moderate impact; and electroforming and solar cell NASA-sponsored work had light impact on the national economy. M.W.R.

N68-34391*# Stanford Research Inst., Menlo Park, Calif.
SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 1. IDENTIFICATION OF NEW OCCUPATIONS—FORMULATION AND INITIATION OF STUDY
Roger W. Hough, Gail L. Knudtson, and Shirley Thomas May 1968 26 p refs *Its* Aerospace Systems Ser. v. 1
(Contract NASw-1722; SRI Proj. Mu-7227)
(NASA-CR-96808) CFSTI: HC $3.00/MF $0.65 CSCL 05C

Both formal and informal inventories of job titles indicate that new occupations have been established in both industry and government as a result of the space program; and five methods were developed for identifying such positions. Initial returns from seven organizations listed 11 job titles, including space vehicle test mechanic, space documentation requirements analyst, environmental space systems assembler, and life support research scientist. Seven other occupations were identified by another method, including those of space electrical power and space power systems engineers, circuit design specialist-space instruments, solar cell engineer, and lab technician-space instrumentation. A uniform resistance to updating job titles in NASA and aerospace industrial organizations were found. Attention is given to the methodology used in this initial study and to search methods and tasks for a future program. M.W.R.

N68-33682*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE ROLE OF THE EXPERIMETER ASSOCIATED WITH MULTI-EXPERIMENT SCIENTIFIC SATELLITES
George H. Ludwig Washington Sep. 1968 14 p Presented at the AIAA Space Program Issues of the 70's Meeting, Seattle, 28 Aug. 1967
(NASA-TN-D-4731) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The primary objective of the scientific investigators concerned with scientific spacecraft is to obtain interpretable measurements from their sensors. An additional primary objective of university investigators is to train students in the space sciences and research techniques. To achieve these objectives, the investigators must help define mission requirements; participate in mission planning, instrument development, integration and testing, prelaunch activities, and operations; and be prepared to analyze the data upon receipt. Prelaunch preparations must be kept as short as possible commensurate with reasonable success probabilities, provide a reasonable balance between system capability and simplicity, and provide flight data as rapidly as possible. Improvements to present flight programs can be made in several areas. The experiment life cycle needs shortening, and greater simplification of the experiment/spacecraft interfaces is desirable. Technical and management coordination should be simplified and made more direct. Experimenters need better financial management, improved ability to meet schedules, better quality control, and better preparation for data reduction after launch. Author

N68-34695*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE INFLUENCE OF FACULTY INVOLVEMENT WITH NASA ON THEIR TEACHING OF AEROSPACE ENGINEERING

Walter T. Olson [1968] 24 p Presented at the Am. Soc. for Eng. Educ. Ann. Meeting, Los Angeles, 17–20 Jun. 1968
(NASA-TM-X-61241) CFSTI: HC $3.00/MF $0.65 CSCL 05A

The kinds of activity and the interaction that NASA has had with universities are reviewed in terms of the total investment of NASA funds. These include grants and contracts in support of NASA programs or projects, and a sustaining program of grants in support multidisciplinary studies, training, and facilities. Case histories are recounted to show that the kinds of influence on teaching range from the creation of whole new departments down to a timely illustration in someone's lecture. Considered important are the challenge which has been presented to scientists and engineers to work together on aerospace tasks requiring a multidisciplinary approach, and the disappearance of traditional barriers between departments and disciplines. M.G.J.

N68-34733*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.
AN IDEA WHOSE TIME HAS COME... [EINE IDEE, DEREN ZEIT GEKOMMEN IST...]
Franz Zeithammer NASA Jun. 1968 8 p Transl. into ENGLISH from Kosmos (Stuttgart), No. 3, Mar. 1967 p 115–119
(Contract NASw-1693)
(NASA-TT-F-11480) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A short, general description of the Marshall Space Flight Center, Huntsville, Ala., is presented by a visiting German journalist who also interviewed the director of the facility. Some broad aspects of the NASA space program were briefly discussed during the interview. K.W.

N68-34800*# National Aeronautics and Space Administration, Washington, D. C.
USEFUL TECHNOLOGY FROM SPACE RESEARCH
1968 20 p
(NASA-TM-X-61175) GPO: HC $0.15; CFSTI: MF $0.65 CSCL 05B

Presented is a review of NASA Technology Utilization Program services available to industry. Reported is the development of a computer technique for clarifying photographs transmitted from the Moon and Mars to Earth which can also enhance the value of x-ray pictures for medical diagnoses. NASA research focusing on the prevention of aircraft skidding on wet runways by grooving runway surfaces which resulted in 90% reduction of rainy-day automobile accidents in those areas adopting this approach is also cited. Reviewed are NASA publications; regional dissemination centers; a listing of libraries that have NASA Technical Reports; NASA special services (i.e., computer programs, biomedical application teams and interagency activities); and NASA's patents and license regulations. Included are brief summaries which illustrate several typical technology transfers. Data on technology utilization services, sources, and costs are also included. S.C.W.

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